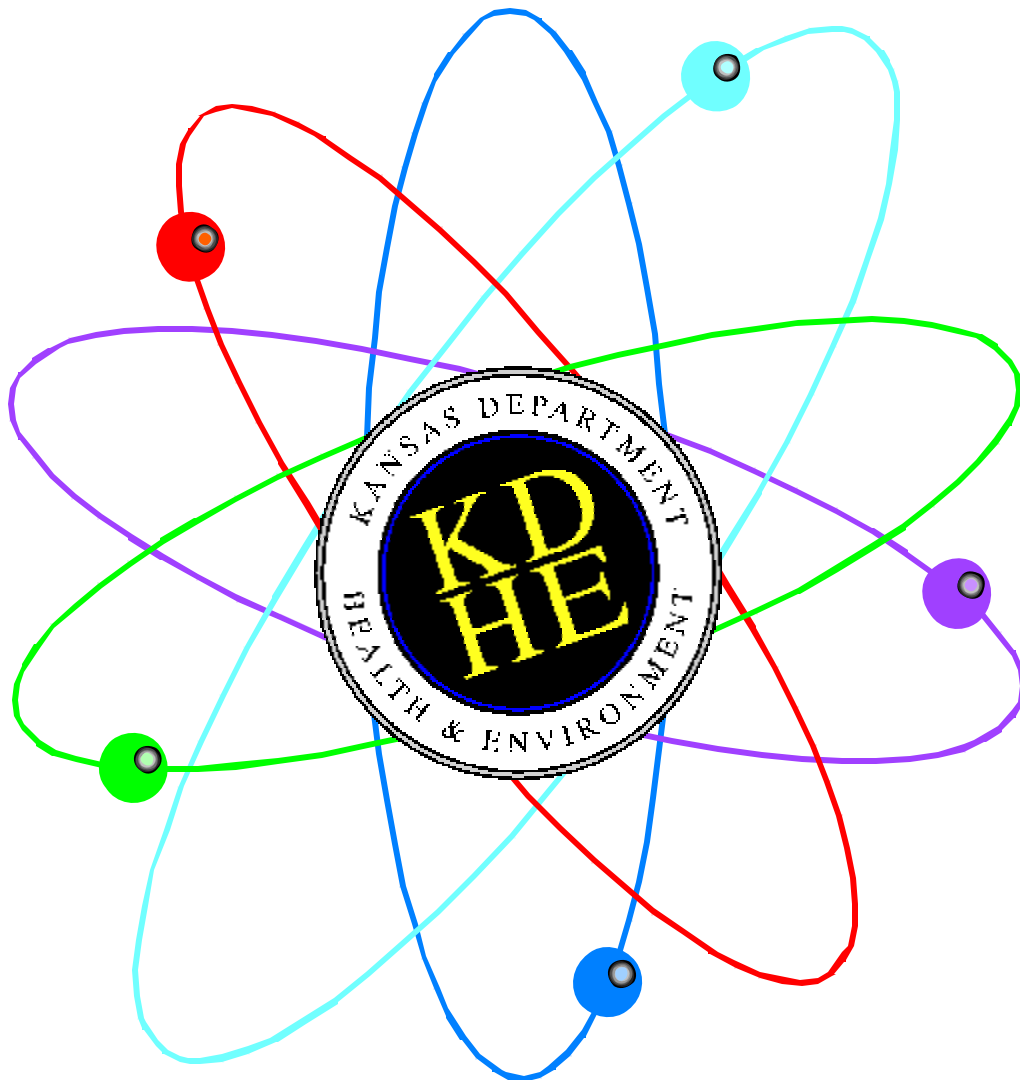


**WOLF CREEK GENERATING STATION
ENVIRONMENTAL RADIATION SURVEILLANCE REPORT**



July 1999-June 2000

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT

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WOLF CREEK GENERATING STATION ENVIRONMENTAL RADIATION SURVEILLANCE REPORT SFY 2000

INTRODUCTION

This report covers the results of sampling conducted in the environment surrounding Wolf Creek Generating Station (WCGS) from July 1, 1999 to June 30, 2000 (SFY 2000) by the Kansas Department of Health and Environment (KDHE) according to K.A.R. 28-19-81. KDHE's WCGS environmental radiation surveillance program began in 1979 with the initiation of selected surface water locations, and was fully set up by 1984.

In July of 1984 a cooperative agreement was established between KDHE and the United States Nuclear Regulatory Commission (NRC). The cooperative agreement, denoted NRC-31-84-502, established an NRC radiation monitoring network, set criteria for split samples, and designated collocated air sampling stations. The NRC cooperative agreement ended effective December 31, 1997. The NRC TLD network was dismantled but other program elements remain and are a fundamental part of KDHE's quality assurance program. KDHE's quality assurance program gives reasonable confidence that the environmental measurements obtained by WCNOG, a licensee of the NRC, are valid.

WCGS became fully operational in 1985, allowing for a year of preoperational data collection for use as a baseline. The purpose of the operational environmental radiation surveillance program, instituted in 1985, is to detect, identify, and measure any radioactive material released to the environment in effluents resulting from the operation WCGS. If elevated levels of radioactivity are detected, this information will then be used to decide whether corrective or protective actions should be taken.

Although not its primary function, the operational environmental radiation surveillance program is also essential to the State's *Nuclear Facilities Incident Response Plan*. If an accidental release of radioactive materials from WCGS should occur, data collected from air and radiation monitoring sites will be used to accurately calculate doses to affected populations and to assess any environmental impact.

The WCGS environmental radiation surveillance program includes monitoring of ambient external radiation levels using thermoluminescent dosimetry (TLD), monitoring of concentrations of radionuclides present in ambient air through weekly collection and laboratory analysis of continuous air samples, and monitoring of concentrations of radionuclides and specific isotopes in the environment surrounding the WCGS through the scheduled collection and laboratory analysis of water, milk, terrestrial vegetation, aquatic vegetation, fish, game animal, domestic meat, sediment, and soil samples. A tabular summary of the WCGS environmental radiation surveillance program conducted during SFY 2000 is presented as Table I.

PROGRAM DESCRIPTION

State personnel did or were present at all routine environmental sampling, sample splitting with WCNOG personnel, and sample preparation and analysis unless otherwise specified. Sample collection at collocated sites is coordinated with WCNOG environmental personnel so that sample results cover the same period. Where split samples are required, every effort is made to have a KDHE employee present at the time of sample collection. Samples are returned to KDHE offices at Forbes Field after collection. Analyses are done in the KDHE Radiochemistry Laboratory at Forbes Field. State TLDs are processed by the Environmental Radiation and Emergency Preparedness (ER&EP) section of the Radiation Control Program of the Bureau of Air and Radiation. Program modifications may be made due to specimen unavailability, weather conditions, malfunction of analytical equipment, unavailability of staff, or other unforeseen circumstances.

WCNOG has a contract with Teledyne Brown Engineering Environmental Services for laboratory analysis of samples collected in the WCGS environs. Samples are collected by WCNOG personnel. TLDs are evaluated by Enrico Fermi Unit 2.

Air

Five air sampling sites, three of which are collocated with WCNO, have continuously operating low-volume air samplers contained in a fiberglass housing mounted to utility poles approximately one meter from the ground. Air samplers are located at Sharpe, East of the Coffey County Lake dam, Burlington, New Strawn, and Hartford. The collocated sites include the highest calculated annual average ground level relative concentration (C/Q) area at Sharpe, the highest calculated annual average ground level relative deposition (D/Q) area at New Strawn, and a control location at Hartford. An average flow rate of about 30 liters per minute is used with 47 mm diameter glass fiber particulate filters and 5 percent TEDA (Tri-ethylene di-Amine) impregnated carbon cartridges for radioiodine activity (the major isotope of concern is ^{131}I). TEDA acts as a chelating agent to bind the iodine chemically and reduce loss by desorption.

Air samples are collected weekly. A gross beta analysis is done on each air particulate filter collected, nominally 72 hours after sample collection. The waiting period allows for the decay of naturally occurring short-lived radon (^{222}Rn) or thoron (^{220}Rn) progeny that may interfere with the analysis. The gross beta analysis is used for comparison with WCNO results for the same period. A gamma isotopic analysis is done on two composite samples, one composed of five particulate filters and the other five charcoal cartridges. Indication of ^{131}I or any other fission or activation product requires that a gamma isotopic analysis be done on each individual particulate filter and associated charcoal cartridge.

Direct radiation monitoring

Direct radiation monitoring is accomplished by the Radiation Control Program's thermoluminescent dosimetry (TLD) system, which consists of a Victoreen 2800M reader using Victoreen Model 2600-49 axial bulb manganese-doped calcium fluoride ($\text{CaF}_2:\text{Mn}$) dosimeters. Dosimeters are individually calibrated to ^{137}Cs (cesium) and each reading is corrected for fading, self irradiation, and any dose received while in transit.

Thirty-one locations around the WCGS are monitored by KDHE, including three control locations greater than ten miles from WCGS. Three bulb dosimeters are used per site to generate an average quarterly reading per site. The dosimeters are contained in specially constructed PVC plastic holders suspended approximately one meter above the ground. Staff exchange TLDs quarterly. KDHE has collocated TLDS with WCNO at fourteen sites. WCNO uses Panasonic Model UD-814-AQ TLDs. Each dosimeter consists of one lithium borate element and three calcium sulfate elements in a plastic case.

Surface water

Surface water sampling is done by the collection of one gallon (3.8 L) grab samples at the indicated locations. Three locations are collected monthly. One control sample is collected monthly below the John Redmond Reservoir dam near the makeup screen house. Two samples are collected from the Coffey County Lake, one at the discharge cove and the other at the spillway. Samples are also collected annually from two ponds found within five miles of the facility. Gross alpha, gross beta, tritium (^3H), and a gamma isotopic analysis is done on each water sample. Samples split with WCNO include the control sample at JRR and the two Coffey County Lake samples.

Ground water

Ground water is collected quarterly at a well in sector B (control), J, L, and N. The control sample location is hydrologically up gradient from the facility and the other three are hydrologically down gradient. The same analyses are done on ground water as are done on surface water. Samples are split with WCNO.

Drinking water

Two public water supplies are sampled for drinking water. These water supplies use the Neosho River as a drinking water source. Burlington is sampled as a control location, being upstream from the WCGS, and LeRoy, the first public water supply downstream of the WCGS, is also sampled. Both sites are collocated with WCNO. Samples are collected from the water distribution system monthly by Bureau of Water (BOW)

personnel and composited quarterly for gross alpha, gross beta, tritium, and gamma isotopic analysis. An annual composite of four consecutive quarterly samples is analyzed for strontium (^{89}Sr and ^{90}Sr).

An additional water sample is collected monthly by ER&EP personnel at LeRoy from the water plant settling basin. An ISCO™ water sampler collects 150 mL every 12 hours over a 30 day period. Gross alpha, gross beta, tritium, and a gamma isotopic analysis is done on each sample collected.

WCNOC operates and maintains a similar water sampler both at Burlington and at LeRoy. WCNOC water samplers collect 10 mL every hour over a 30 day period. The samples are collected monthly by WCNOC personnel.

Milk

A milk sample is collected quarterly in Coffey County at a dairy near Lebo. This sample is a control and no indicator locations are available within the 10-mile Emergency Planning Zone of WCGS. The milk sample is analyzed for low levels of radioiodine (major isotope of concern is ^{131}I) and other gamma emitting nuclides. A strontium analysis is done annually.

Sediment and soil

Shoreline sediment, bottom sediment, and soil samples are taken in the environment surrounding WCGS. Sediment samples are collected semiannually in the Coffey County Lake discharge cove, public environmental education area (shoreline only), and public fishing area (shoreline only). Sediment samples are also collected on Wolf Creek below the Coffey County Lake dam, and at John Redmond Reservoir. The sediment samples obtained at John Redmond Reservoir are used as controls. The Coffey County Lake and John Redmond Reservoir sediment samples are split with WCNOC. Soil samples are collected semiannually close to Sharpe, east of WCGS at the Scott Valley Church (control), east of the Coffey County Lake dam, and at the Coffey County Lake public fishing and environmental education areas. Soil samples collected from the Coffey County public use areas are split with WCNOC. A gamma isotopic analysis is done on all sediment and soil samples collected. A strontium analysis is done on any sediment sample collected in the Coffey County Lake discharge cove and may be done on other sediment or soil samples based upon the gamma isotopic analysis results.

Fish, game animals, and domestic meat

Fish are collected semiannually from the Coffey County Lake and below John Redmond Reservoir on the Neosho River. Fish or invertebrates may be collected along Wolf Creek (including Coffey County Lake outlet pool) or on the Neosho River below the confluence. Sample portions from fish collected in the Coffey County Lake, outlet pool, and below John Redmond Reservoir on the Neosho River are split with WCNOC. Fish collected at John Redmond Reservoir on the Neosho River are used for control samples. Game animal sampling is usually limited to the collection of edible meat portions from road-killed deer. Sample portions of road-killed deer are usually collected by WCNOC and split with KDHE for laboratory analysis. Domestic meat samples are obtained from meat lockers at Burlington or LeRoy. A gamma isotopic analysis is done on all samples collected. Sample portions are usually edible, however, inedible portions may also be analyzed. Tritium in tissue analysis (fat and water) is done on all edible fish samples collected.

Terrestrial and aquatic vegetation

Terrestrial vegetation samples are taken at various locations around the WCGS. This includes samples of crops grown throughout Coffey County, broad leaf vegetation taken from gardens near the WCGS boundary, pasturage near WCGS, and crops irrigated with water from the Neosho River. Pasturage samples are usually collected concurrently with soil samples. A gamma isotopic analysis is done on each vegetation sample and edible portions of food products collected. A strontium analysis is done on selected samples based upon gamma isotopic analysis results. Samples split with WCNOC include pasturage samples collected at the Coffey County Lake public use areas, garden vegetables collected from gardens near WCGS, and samples of crops irrigated with water from the Neosho River.

If available, aquatic vegetation (algae and rooted aquatics) samples are collected semiannually from the Coffey

County Lake, Wolf Creek below the Coffey County Lake dam, and John Redmond Reservoir. The aquatic vegetation samples obtained at John Redmond Reservoir are used as controls. The Coffey County Lake samples are split with WCNO. A gamma isotopic analysis is done on all aquatic vegetation samples collected. A strontium analysis is done on any aquatic vegetation sample collected in the Coffey County Lake discharge cove and may be done on other aquatic vegetation samples based upon the gamma isotopic analysis results.

EQUIPMENT

The following is a description of the equipment used by the KHEL Radiochemistry laboratory.

Multichannel gamma-spectrometer

Gamma radiation is measured and classified by using a Canberra Genie-2000 MCA System. Detectors available are a Harshaw 3-inch x 3-inch NaI(Tl) crystal, a 105cc (20 percent efficiency) GeLi crystal, a 40 percent efficient HPGe crystal, and a 15 percent efficient HPGe crystal.

Low background alpha/beta system

An Oxford Series 5XLB and a Tennelec 5100 alpha/beta low background IPC system is used for strontium (^{89}Sr and ^{90}Sr), radium (^{228}Ra), and gross beta counting.

Internal proportional counter (IPC)

Gross alpha, uranium, and radium analyses are made with four Nuclear Measurement Corporation (NMC) windowless gas flow IPC systems.

Liquid scintillation

Tritium, nickel (^{63}Ni), and radon (^{222}Rn) in water analyses are performed using a Beckman LS-230 and a Wallac-1409 liquid scintillation system.

Miscellaneous equipment

The Radiochemistry Section has several pieces of equipment used for special projects. A Ludlum Model 2200 single channel analyzer is used with a radon flask scintillation counter for radon and radium analyses. Another Ludlum Model 2200 single channel analyzer is used with a halogen quenched GM pancake probe for routine monitoring of personnel and incoming samples.

QUALITY ASSURANCE

The KDHE Radiation Laboratory has an established internal Quality Assurance program. Quality Control elements include routine calibrations and performance checks on counting equipment (see Table 16.0). The KDHE ER&EP section of the Radiation Control Program has also participated in six International Environmental Dosimeter Intercomparison Studies since 1979 for the State's TLD system, and two informal intercomparisons with another state and with EPA Region 7 users of Victoreen TLD systems.

Units

The unit of radioactivity used is the picoCurie (pCi). One pCi is equal to 2.22 disintegrations per minute or 0.037 Becquerels (Bq). Radioactivity concentrations in liquids such as water and milk are expressed in picoCuries per liter (pCi/L), radioactivity concentrations in air are expressed in picoCuries per cubic meter (pCi/m³), and radioactivity in solids such as soil or vegetation is expressed in picoCuries per kilogram (pCi/kg). TLD exposure results are expressed as milliRoentgen (mR) per a 90-day quarter. One mR is also equivalent to ten micro-Grays (10 μGy or 10^{-5} Gy).

Uncertainty statistics

Radioactive decay of unstable atomic nuclei is a totally random event. The larger the number of total counts obtained and the longer each sample is counted, the closer the measurements will be to their actual value. Due to the large number of samples to be analyzed and the limited time available for counting individual samples, each sample is counted only once and for a certain limited period to reduce the statistical error to an acceptable level. Unless otherwise specified, results for all samples are reported at the 95 percent confidence level. Because estimates of systematic (non-random) uncertainties involved in sample collection and sample preparation are highly subjective and generally difficult or impossible to achieve with any substantial accuracy, the KDHE Radiochemistry Laboratory reports only the uncertainty resulting from random processes (propagation of statistical counting error).

A "less than" value reported shows that the radioactivity in the sample is below the lower limit of detection for the procedures, equipment, and counting time used. The KHEL Radiochemistry Laboratory method detection limits (MDLs) for various analyses are summarized in Table 16.0 of this report. MDLs depend on the sample matrix, sample size, counting time, detector efficiencies, and type of measurement required. WCNO's lower limits of detection values are found in Table 17.0.

RESULTS

Results are reported in the following data tables for the samples taken around WCGS during SFY 2000. Radionuclides detected in the environment surrounding WCGS during SFY 2000 included ^{228}Ac , ^7Be , ^{58}Co , ^{60}Co , ^{134}Cs , ^{137}Cs , ^3H , ^{40}K , ^{54}Mn , ^{226}Ra , ^{125}Sb , and ^{228}Th . The isotopes ^{228}Ac , ^7Be , ^{40}K , ^{226}Ra , and ^{228}Th are naturally occurring radionuclides common to most sample types. The isotopes ^{137}Cs , ^3H , and ^{125}Sb are fission products formed from WCGS nuclear reactor operation. The isotopes ^{58}Co , ^{60}Co , ^{134}Cs , and ^{54}Mn are activation products, also formed from WCGS nuclear reactor operation. A small background component of the ^3H (half-life = 12.3 y) and ^{137}Cs (half-life = 30.1 y) activity is due to previous nuclear weapons tests. Small amounts of ^3H are also produced naturally from cosmic ray interactions with water vapor in the upper atmosphere. Background levels of ^{137}Cs and ^3H are accounted for in control samples and in preoperational data. The fission and activation product activity levels found to date in the environment surrounding WCGS are not above expected regulated levels and are very small when compared with activity levels due to naturally occurring radionuclides.

The most significant radionuclide present in surface water samples collected in the Coffey County Lake is ^3H , a beta emitter. The highest ^3H concentration measured in the Coffey County Lake during SFY 2000 was 16,678 pCi/L. This maximum Coffey County Lake ^3H concentration is 83 % of the National Primary Drinking Regulation maximum contaminant level (MCL) of 20,000 pCi/L. The water from the Coffey County Lake is not used as a drinking water source. All other surface water, ground water, and drinking water samples collected in the environs of WCGS during SFY 2000 indicated no radionuclides present attributable to the operation of WCGS.

Algae and sediment samples are used as indicators for the monitoring of a fission and activation product buildup in the environment surrounding WCGS. Algae samples have been the best indicators for monitoring the seasonal fluctuations of fission and activation product levels in the Coffey County Lake. Sediment samples have been excellent indicators for the long term buildup of fission and activation product activity levels in the Coffey County Lake. The highest fission product activity (other than ^3H) during SFY 2000 was 680 ± 200 pCi/kg-dry ^{137}Cs found in a Coffey County Lake Public Access Area shoreline sediment sample (it should be noted that a control bottom sample contained a ^{137}Cs concentration of 203 ± 18 pCi/kg-dry). The highest activation product activity observed during SFY 2000 was 816 ± 37 pCi/kg-dry ^{60}Co found in a Coffey County Lake DC bottom sediment sample.

Airborne sample analysis showed that no radionuclides attributable to the operation of WCGS were present above the lower limits of detection during SFY 2000. The highest gross beta activity noted was 0.092 pCi/m³, due primarily to naturally occurring ^{222}Rn progeny, specifically the long-lived isotope ^{210}Pb (half-life = 21 y).

Sample analysis of terrestrial vegetation, soil, milk, grain, and vegetable samples collected in the environs of WCGS during SFY 2000 indicated no radionuclides present attributable to the operation of WCGS. The maximum activity found in aquatic vegetation collected in the Coffey County Lake DC was 600 pCi/kg-dry ^{90}Sr (algae collected at the Discharge cove boat ramp). Also of note, this year has been a drought year with significantly less rainfall than last FY. Since November of 1999 CCL levels have been below the normal level

of 1080 ft ASL, averaging 1.5 to 3 feet below normal.

A total of forty-five fish were taken from the Coffey County Lake during SFY 2000. Sample analysis of edible fish portions collected in the environs of WCGS during SFY 2000 showed 41 ± 16 pCi/kg ^{137}Cs , as analyzed by WCNO, in one composite Walleye sample from the Ultimate Heat Sink of CCL. KDHE samples showed <32 pCi/kg ^{137}Cs on the same sample. All edible fish samples collected during SFY 2000 were also analyzed for ^3H (tritium) in tissue (fat and water). The highest ^3H concentration in tissue was 11,003 pCi/kg-wet found in a Smallmouth Buffalo sample taken at the Coffey County Lake Discharge Cove. No other radionuclides attributable to Wolf Creek operations were found. Using an ICRP 30 dose conversion factors for ingestion, $6.40\text{E-}08$ mrem per pCi ^3H ingested and $5.01\text{E-}05$ mrem per pCi ^{137}Cs ingested, a standard man consuming 21 kg/y of fish containing 11,003 pCi/kg ^3H and 41 pCi/kg ^{137}Cs would receive a committed effective dose equivalent of 0.058 mrem. This projected dose equivalent is far below the 100 mrem/y regulatory limit set for an individual member of the public.

Direct radiation monitoring sites showed no significant changes from preoperational data. The grand yearly average of all sites was 75 mR/y, corresponding to 8.5 $\mu\text{R/h}$. The lowest direct radiation levels are found closest to the WCGS. The direct radiation levels on the Coffey County Lake baffle dikes at the 1,200 m exclusion area boundary are the lowest of any monitored site. The average baffle dike direct radiation level for SFY 2000 was 52 mR/y, corresponding to 6 $\mu\text{R/h}$. Limestone was used to construct the baffle dikes, and has a lower natural background radioactivity than the original soil present before the construction of the Coffey County Lake. This effect of construction on the terrestrial component of natural background radiation was noted on radiation surveys conducted around the WCGS site before bringing the initial fuel load on the site. The water from the Coffey County Lake also acts as an effective shield from terrestrial radiation that was present before lake filling.

As of January 2000, the Radiation Laboratory began using samples provided by Environmental Resource Associates of Arvada, Colorado for their performance evaluation program. This evaluation program replaced the EPA intercomparison program that was discontinued in November of 1998. (See Table 16.0) No game animals or domestic beef samples were collected during SFY 2000, this is due to lack of sufficient information to track source animals in a 'cradle to grave' fashion.

Table II gives summary statistics for data collected by KDHE. Data comparisons were made between KDHE and WCNO. The ratio of KDHE results to WCNO results ranged from 0.9 to 4.9. A summary of comparison data may be found in Tables III and IV. Data tables, graphs, and figures are also attached.

Table I. Wolf Creek Generating Station environmental radiation surveillance program summary SFY 2000. Tabular summary of sample stations used and numbers of samples collected.

Type of sample	No. of sampling stations	Total samples collected ^a
Air (particulate filter and charcoal cartridge)	5	528
Direct radiation (TLD)	31	418 ^b
Surface water	5	38
Ground water	4	16
Drinking water	2	20
Sediments	7	15
Aquatic vegetation	4	4
Milk	1	4
Fish	4	18
Game animals and domestic meat	1	0 ^d
Soil	6	10
Terrestrial vegetation ^c	12	17
Grand Total	82	1088

^a Total number of analyses for SFY 2000 were 1118 (includes TLD evaluations).

^b Includes control TLDs and TLD's used for transit exposure determination. There are three TLDs per sample station evaluated four times per year.

^c Terrestrial vegetation includes garden vegetables, food products, grain, and pasturage.

^d Domestic meat samples were not collected. This was due to the inability to adequately track the origin of the animal to locations within the Wolf Creek primary ingestion pathway zone. Game animals were not collected by WCNOE environmental services. This sample is usually from road kill game (deer) collected by WCNOE and split with KDHE. No samples of this type were available during the SFY.

TABLE II. Wolf Creek Generating Station environmental radiation surveillance program summary statistics SFY 2000.

Description	Average	Standard deviation	Standard error of the mean	Min	Max	N
TLD direct radiation, mR per 90 day quarter	18.3 ^a	3.2	0.2	8.3	27.4	372 ^b
Airborne particulate gross beta, pCi/m ³ (72 hour decay)	0.039	0.015	0.001	0.010	0.092	263
Airborne particulate and radioiodine cartridge gamma isotopic analysis	Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any air particulate filter or radioiodine cartridge evaluated.					
Surface water tritium (³ H), pCi/l						
John Redmond Reservoir, control (N-1/MUSH)	<350	**	**	<350	<350	12
Coffey County Lake (Q-1/DC, J1A/SP) ^c	12732	2003	409	10326	16678	24
Ponds surrounding WCGS	<350	**	**	<350	<350	2
Drinking water tritium (³ H), pCi/l						
Burlington, control	<350	**	**	<350	<350	4
LeRoy	<350	**	**	<350	<350	16
Ground water tritium (³ H), pCi/l (All Stations)	<350	**	**	<350	<350	16
Water sample gamma isotopic analysis	Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any surface water, drinking water, or ground water sample evaluated.					
Surface water gross alpha+ beta analysis, pCi/l						
John Redmond Reservoir, control (N-1/MUSH), a+β	7.2	2	0.6	2	11	12
Coffey County Lake (Q-1/DC, J1A/SP), a +β	8.2	2.2	0.5	4	11	24
Gamma isotopic analysis of soil, milk, pasturage, garden vegetables, and grain.	Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any soil, milk, pasturage, garden vegetable and grain sample evaluated.					
Maximum activity by isotope attributable to Wolf Creek Generating Station operation, pCi/kg						
Coffey County Lake discharge cove bottom sediment, dry	816±37 ⁶⁰ Co					
Coffey County Lake discharge cove shoreline sediment, dry	500±100 ⁹⁰ Sr					
Coffey County Lake discharge cove aquatic vegetation (algae), dry	600±100 ⁹⁰ Sr					
Coffey County Lake fish, wet	(2) Smallmouth Buffalo: 11003±1277 ³ H					
Maximum naturally occurring gamma activity, pCi/kg-dry						
Sector J (WCRA-J-1) Rooted Aquatic (Arrowhead), dry	66793±12484 ⁴⁰ K					

^a Corresponds to 8.5 μR/h. ORNL/TM-7343 (1981) gives background radiation levels in Kansas ranging from 7 μR/h to 14 μR/h with an average background of 10±1 μR/h (N=6). Measurements were taken along I-70 from western Kansas to eastern Kansas.

^b Total number of TLD readings evaluated (31 locations with 3 TLDs each read 4 times per year).

^c Includes the Coffey County Lake discharge cove (DC) and the Coffey County Lake spillway (SP).

TABLE III. Wolf Creek Generating Station environmental radiation surveillance program data comparison ^a summary statistics SFY 2000.

Description	Average	Standard Deviation	Standard error of the mean	Min	Max	N
TLD direct radiation, mR ^b	17.6 (18.3)	3.1 (3.1)	0.4 (0.4)	10.2 (11.2)	24.1 (24.3)	56 (56)
Airborne particulate gross beta, pCi/m ³						
Sharpe, A-1 (02)	0.040 (0.026)	0.015 (0.009)	0.002 (0.001)	0.017 (0.012)	0.080 (0.047)	53 (53)
New Strawn, P-1 (32)	0.036 (0.027)	0.014 (0.009)	0.002 (0.001)	0.016 (0.014)	0.067 (0.048)	52 (53)
Hartford (control), P-2 (40)	0.042 (0.027)	0.016 (0.009)	0.002 (0.001)	0.017 (0.012)	0.077 (0.049)	52 (53)
Airborne particulate filter and charcoal cartridge gamma isotopic analysis	Gamma isotopic analysis by both KDHE and WCNO (Teledyne) showed that no gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any particulate filter or charcoal cartridge evaluated.					
Surface water tritium (3H), pCi/R						
CCL ^c spillway, J-1A (SP)	12776(11667)	2131 (1303)	615 (376)	10326(10000)	16678 (14000)	12 (12)
CCL discharge cove, Q-1 (DC)	12688(11383)	1960 (1136)	566 (328)	10404 (9600)	16108 (13000)	12 (12)
JRR ^d below dam (control), N-1 (MUSH)	<350 (<208)	* (*)	* (*)	<350 (<100)	<350 (<300)	12 (12)
Ground water ³ H, pCi/R	<350 (<189)	* (*)	* (*)	<350 (<100)	<350 (<200)	16 (16)
LeRoy drinking water ³ H, H-1 (LW40)	<350 (<250)	* (*)	* (*)	<350 (<200)	<350 (<300)	16 (4)
Surface, ground, and drinking water gamma isotopic analysis	Gamma isotopic analysis by both KDHE and WCNO (Teledyne) showed that no gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any surface, ground, or drinking water sample evaluated.					
Maximum activity by isotope attributable to WCGS operation, pCi/kg						
Bottom sediment/ Shoreline sediment	Gamma emitter: CCL discharge cove, WCBS-Q-1 (L8071), 816±37 ⁶⁰ Co-dry (663±66 ⁶⁰ Co-dry)					
	Beta emitter: CCL discharge cove, WCSS-Q-1 (L8072), 500±100 (not reported) ⁹⁰ Sr-dry					
Algae	Gamma emitter: CCL Discharge cove boat ramp, WCAL-Q-1 (L11363), 143±16 ⁶⁰ Co-dry (154±17 ⁶⁰ Co-dry)					
CCL fish	Gamma emitter: One Walleye composite from CCL ultimate Heat Sink, <32 (41±16) ¹³⁷ Cs					
	Beta emitter: Composite of two Smallmouth Buffalo at 11003±1277 ³ H-wet ,(Composite of two Wiper 7700±300 ³ H-wet)					
Milk, soil, terrestrial vegetation	Gamma isotopic analysis by both KDHE and WCNO (Teledyne) showed that no comparable gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any milk, soil or terrestrial vegetation sample evaluated.					
Maximum naturally occurring gamma activity on co-located samples, pCi/kg						
Sector R EEA ^e pasturage at 34736±3143 ⁴⁰ K-dry, (13900±1400 ⁴⁰ K-wet) Wet to dry ratio for this sample is 2.41.						

^a KDHE (WCNO).

^b mR per 90-day quarter.

^c Coffey County Lake.

^d John Redmond Reservoir.

^e Environmental Education Area

Table IV. Data comparison summary by selected analyses SFY 2000.

Analysis	Average ratio of KDHE results to WCNOC results ^a	Comments
Air particulate filter gross beta	1.5±0.0 N=157	This corresponds to a relative agreement of 33 %. The primary reason for the results is due to the decay time chosen before counting the particulate filter. KDHE allows for a nominal waiting period 72 hours while WCNOC (Teledyne) had a waiting period of 5 to 29 days (Average of 16 days). Other factors include systematic differences in air sampler calibration procedures and correction factors used for calculating self absorption effects due to air particulate filter dust loading. When comparing the relative agreement between KDHE and WCNOC (Indicator result/Control result), the airborne duplicate gross beta results were within 10 % of each other.
Air particulate filter gamma isotopic	2.1±0.2 N=4	This corresponds to a relative agreement of 52 %. The isotope used for comparison was ⁷ Be (t _{1/2} = 53 days). WCNOC composites particulate filters by location for quarterly analysis. KDHE analyzes a five-filter composite across all locations weekly. The comparison was made using quarterly averages.
TLD direct radiation	1.0±0.0 N=56	Fourteen sites are collocated.
Surface water tritium (³ H)	1.1±0.0 N=24	This corresponds to a relative agreement of 9 %. The results compared are for the CCL (J-1A(SP) and Q-1(DC)).
Soil gamma isotopic	1.5±0.4 N=18	This corresponds to a relative agreement of 33 %. Isotopes used for comparison were ¹³⁷ Cs, ⁴⁰ K, ²²⁸ Th and ²²⁶ Ra.
Bottom sediment gamma isotopic	1.6±0.35 N=21	This corresponds to a relative agreement of 38 %. Isotopes used for the comparison were ⁷ Be, ⁶⁰ Co, ¹³⁷ Cs, ⁴⁰ K, and ²²⁶ Ra, and ¹²⁸ Th.
Shoreline sediment gamma isotopic	1.5±0.3 N=26	This corresponds to a relative agreement of 33 %. Isotopes used for the comparison were ⁷ Be, ¹³⁷ Cs, ⁴⁰ K, ¹²⁸ Th and ²²⁶ Ra.
Terrestrial vegetation gamma isotopic-pasturage	4.9±1.8 N=8	The results for KDHE are reported as pCi/kg-dry while the WCNOC results are reported as pCi/kg-wet. The wet weight to dry weight ratio for the samples compared was 2.7±1.4. Isotopes used for comparison were ⁷ Be and ⁴⁰ K. When the WCNOC results are normalized to a dry-weight reporting basis, the KDHE/WCNOC ratio improves to 1.8 with a relative agreement of 44 %. The low relative agreement is due to an anomalously high ⁷ Be value reported by WCNOC on one pasturage sample. ^b
Terrestrial vegetation gamma isotopic-grain	0.9±0.5 N=3	This corresponds to a relative agreement of 11 %. The results for KDHE and WCNOC results are reported as pCi/kg-wet. Isotope used for comparison was ⁴⁰ K.
Terrestrial vegetation gamma isotopic-garden vegetables (squash and corn leaves)	4.0±2.8 N=2	The results for KDHE are reported as pCi/kg-dry while the WCNOC results are reported as pCi/kg-wet. The wet weight to dry weight ratio for the samples collected was 5.0±3.5. Isotopes used for comparison were ⁷ Be and ⁴⁰ K. When the WCNOC results are normalized to a dry-weight reporting basis, the KDHE/WCNOC ratio improves to 0.8 (a relative agreement of 25 %).
Aquatic vegetation gamma isotopic	3.4±0.8 N=18	The results for KDHE are reported as pCi/kg-dry while the WCNOC results are reported as pCi/kg-wet. The wet weight to dry weight ratio for the samples collected was 4.4±2.2. Isotopes used for comparison were ⁷ Be, ⁶⁰ Co, ¹³⁷ Cs, ⁴⁰ K, ²²⁸ Th, and ²²⁶ Ra. When the WCNOC results are normalized to a dry-weight reporting basis, the KDHE/WCNOC ratio improves to 0.8 with a relative agreement of 25%.
Fish gamma isotopic	1.3±0.3 N=18	This corresponds to a relative agreement of 23 %. The isotope used for comparison was ⁴⁰ K.
Fish tritium (³ H) in tissue	1.6±0.5 N=11	This corresponds to a relative agreement of 38 %. WCNOC samples are analyzed for tritium content in the water of the tissue while KDHE analyzes for the tritium content in the fat and water of the tissue.

^a KDHE/WCNOC±SEM. The relative agreement is given by the absolute value of (1-WCNOC/KDHE)×100%.

^b The anomalous value was on the 11/30/99 MUDS sample. WCNOC reported 19300±1900 pCi/kg vs. KDHE's reported value of 9978±967 pCi/kg. This value is not consistent with all other compared ⁷Be measurements in that WCNOC reporting levels are generally 3 to 5 times lower than KDHE values when uncorrected for wet to dry ratios.

**WOLF CREEK GENERATING STATION
ENVIRONMENTAL RADIATION SURVEILLANCE REPORT
KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT
SFY 2000**

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TABLE 1.0 KDHE weekly samples for airborne particulate radionuclides SFY 2000. 72 h gross beta results in pCi/m³. Results reported at the 95% confidence level (± 0.002 to 0.004 pCi/m³). Weekly five-charcoal cartridge and five-particulate filter composite gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek operation were present above the lower limits of detection. WCNOG sample location designations are denoted by parenthesis.

Date	A-1 (2) Sharpe	H-1 East of CCL dam	L-1 Burlington	P-1 (32) New Strawn	P-2 (40) Hartford control
01-Jul-99	0.020	0.018	0.017	0.018	0.017
08-Jul-99	0.025	0.028	0.028	0.024	0.027
15-Jul-99	0.035	0.032	0.036	0.033	0.035
22-Jul-99	0.037	0.037	0.042	0.035	0.040
29-Jul-99	0.051	0.051	0.043	0.043	0.048
05-Aug-99	0.038	0.010	0.043	0.031	0.033
12-Aug-99	0.052	0.050	0.057	0.043	0.052
19-Aug-99	0.042	0.040	0.025	0.038	0.038
26-Aug-99	0.050	0.047	0.053	0.044	0.060
02-Sep-99	0.080	0.075	0.092	0.067	0.070
09-Sep-99	0.047	0.044	0.074	0.016	0.048
16-Sep-99	0.030	0.030	0.033	0.026	0.035
23-Sep-99	0.039	0.038	0.039	0.037	0.040
30-Sep-99	0.030	0.028	0.033	0.030	0.032
07-Oct-99	0.033	0.032	0.036	0.035	0.039
14-Oct-99	0.059	0.054	0.052	0.054	0.074
21-Oct-99	0.043	0.043	0.052	0.043	0.055
28-Oct-99	0.053	0.048	0.069	0.055	0.062
04-Nov-99	0.049	0.042	0.058	0.045	0.059
12-Nov-99	0.061	0.054	0.074	0.062	0.077
18-Nov-99	0.059	0.048	0.059	0.054	0.065
24-Nov-00	0.057	0.049	0.049	0.053	0.061
02-Dec-99	0.043	0.037	0.037	0.039	0.041
09-Dec-99	0.067	0.056	0.067	0.059	0.069
16-Dec-99	0.045	0.036	0.049	0.040	0.039
22-Dec-00	0.033	0.031	0.034	0.033	0.036
29-Dec-00	0.041	0.034	0.049	0.036	0.049
06-Jan-00	0.056	0.047	0.056	0.048	0.051
13-Jan-00	0.035	0.030	0.037	0.031	0.032
20-Jan-00	0.064	0.052	0.059	0.047	0.060
27-Jan-00	0.046	0.038	0.042	0.038	0.042
03-Feb-00	0.050	0.048	0.063	0.049	0.065
10-Feb-00	0.072	0.054	0.070	0.064	0.071
17-Feb-00	0.060	0.053	0.052	0.055	0.055
24-Feb-00	0.030	0.030	0.032	0.028	0.029
02-Mar-00	0.027	0.031	0.027	0.026	***+***
09-Mar-00	0.021	0.019	0.02	***+***	0.020
16-Mar-00	0.023	0.023	0.028	0.026	0.025
23-Mar-00	0.024	0.020	0.023	0.017	0.021
30-Mar-00	0.027	0.023	0.033	0.022	0.026
06-Apr-00	0.032	0.030	0.031	0.027	0.034
13-Apr-00	0.039	0.035	0.049	0.030	0.040
20-Apr-00	0.022	0.019	0.025	0.019	0.022
27-Apr-00	0.033	0.027	0.040	0.029	0.037
04-May-00	0.035	0.038	0.051	0.033	0.040
11-May-00	0.024	0.020	0.027	0.017	0.026
18-May-00	0.028	0.026	0.034	0.023	0.029
25-May-00	0.036	0.032	0.041	0.033	0.035
01-Jun-00	0.030	0.029	0.030	0.025	0.028
08-Jun-00	0.020	0.023	0.027	0.021	0.023
15-Jun-00	0.020	0.018	0.019	0.017	0.023
22-Jun-00	0.017	0.015	0.017	0.017	0.023
29-Jun-00	0.030	0.020	0.030	0.020	0.036

Gamma emitting radionuclides routinely analyzed for include ⁷Be, ⁴⁰K, ⁵¹Cr, ⁵⁴Mn, ^{58/60}Co, ⁵⁹Fe, ⁶⁵Zn, ⁶⁷Ga, ⁹⁵Nb, ⁹⁵Zr, ⁹⁹Mo, ^{99m}Tc, ¹⁰³Ru, ¹⁰⁶Ru, ^{110m}Ag, ¹¹¹In, ¹²³I, ¹²⁵Sb, ¹³¹I, ^{134/137}Cs, ¹⁴⁰Ba, ¹⁴⁰La, ^{141/144}Ce, ¹⁶⁹Yb, ²²⁶Ra, ²²⁸Ac, ^{234/228}Th, and ²³⁹Np. The naturally occurring radioisotope ⁷Be was detected on the particulate filter composite samples (0.02 pCi/m³ to 1.39 pCi/m³ with a mean of 0.15 ± 0.02 pCi/m³, N=53). See Figure 1 for sample locations.

TABLE 1.1 Weekly duplicate samples for airborne radionuclides SFY 2000. **Gross beta results in pCi/m³.** Results reported at the 95% confidence level (± 0.002 to 0.004 pCi/m³). KDHE analyzes particulate filters after a nominal 72 h decay period, while WCNO (Teledyne) analyzes particulate filters after a nominal 144 h decay period (Avg. 384hr.). Gamma isotopic analyses by both KDHE and WCNO of charcoal cartridge and particulate filter composites showed that no gamma emitters attributable to WCGS operation were present above the lower limits of detection. WCNO sample location designations are denoted by parenthesis.

Date collected	A-1 (02), Sharpe		P-1 (32), New Strawn		P-2(40), Hartford control	
	KDHE	WCNO	KDHE	WCNO	KDHE	WCNO
01-Jul-99	0.020	0.012	0.018	0.016	0.017	0.017
08-Jul-99	0.025	0.020	0.024	0.020	0.027	0.020
15-Jul-99	0.035	0.016	0.033	0.020	0.035	0.021
22-Jul-99	0.037	0.020	0.035	0.023	0.040	0.025
29-Jul-99	0.051	0.025	0.043	0.028	0.048	0.026
05-Aug-99	0.038	0.019	0.031	0.019	0.033	0.018
12-Aug-99	0.052	0.036	0.043	0.038	0.052	0.038
19-Aug-99	0.042	0.022	0.038	0.023	0.038	0.024
26-Aug-99	0.050	0.029	0.044	0.030	0.060	0.030
02-Sep-99	0.080	0.041	0.067	0.045	0.070	0.043
09-Sep-99	0.047	0.026	0.016	0.026	0.048	0.029
16-Sep-99	0.030	0.023	0.026	0.024	0.035	0.026
23-Sep-99	0.039	0.029	0.037	0.027	0.040	0.030
30-Sep-99	0.030	0.026	0.030	0.026	0.032	0.027
07-Oct-99	0.033	0.021	0.035	0.025	0.039	0.026
14-Oct-99	0.059	0.040	0.054	0.040	0.074	0.040
21-Oct-99	0.043	0.021	0.043	0.027	0.055	0.028
28-Oct-99	0.053	0.032	0.055	0.035	0.062	0.035
04-Nov-99	0.049	0.034	0.045	0.036	0.059	0.032
12-Nov-99	0.061	0.031	0.062	0.036	0.077	0.036
18-Nov-99	0.059	0.044	0.054	0.045	0.065	0.044
24-Nov-00	0.057	0.047	0.053	0.048	0.061	0.049
02-Dec-99	0.043	0.028	0.039	0.033	0.041	0.032
09-Dec-99	0.067	0.036	0.059	0.039	0.069	0.036
16-Dec-99	0.045	0.037	0.040	0.037	0.039	0.035
22-Dec-00	0.033	0.025	0.033	0.027	0.036	0.022
29-Dec-00	0.041	0.032	0.036	0.031	0.049	0.030
06-Jan-00	0.056	0.039	0.048	0.040	0.051	0.038
13-Jan-00	0.035	0.020	0.031	0.020	0.032	0.022
20-Jan-00	0.064	0.043	0.047	0.043	0.060	0.047
27-Jan-00	0.046	0.028	0.038	0.034	0.042	0.030
03-Feb-00	0.050	0.027	0.049	0.033	0.065	0.033
10-Feb-00	0.072	0.038	0.064	0.039	0.071	0.041
17-Feb-00	0.060	0.040	0.055	0.040	0.055	0.043
24-Feb-00	0.030	0.026	0.028	0.024	0.029	0.024
02-Mar-00	0.027	0.020	0.026	0.020	***++***	0.020
09-Mar-00	0.021	0.016	***++***	0.023	0.020	0.020
16-Mar-00	0.023	0.022	0.026	0.020	0.025	0.019
23-Mar-00	0.024	0.018	0.017	0.022	0.021	0.018
30-Mar-00	0.027	0.021	0.022	0.018	0.026	0.018
06-Apr-00	0.032	0.024	0.027	0.024	0.034	0.020
13-Apr-00	0.039	0.023	0.030	0.022	0.040	0.022
20-Apr-00	0.022	0.020	0.019	0.017	0.022	0.020
27-Apr-00	0.033	0.021	0.029	0.020	0.037	0.020
04-May-00	0.035	0.024	0.033	0.022	0.040	0.024
11-May-00	0.024	0.019	0.017	0.019	0.026	0.020
18-May-00	0.028	0.019	0.023	0.025	0.029	0.025
25-May-00	0.036	0.021	0.033	0.019	0.035	0.019
01-Jun-00	0.030	0.024	0.025	0.019	0.028	0.020
08-Jun-00	0.020	0.017	0.021	0.014	0.023	0.014
15-Jun-00	0.020	0.017	0.017	0.017	0.023	0.016
22-Jun-00	0.017	0.012	0.017	0.016	0.023	0.012
29-Jun-00	0.030	0.018	0.020	0.017	0.036	0.017

TABLE 2.0 Wolf Creek quarterly direct radiation monitoring SFY 2000. Direct radiation monitoring results in mR. Reported results include errors associated with correction factors. Exposures are normalized to a 90-day quarter. Results are expressed as the average of three TLD readings per location \pm total uncertainty (s_{UNC}). ^a See Figure 1 for sample locations. WCNOG sample location designations are denoted by parenthesis.

Location ^b KS (WCNOG)	QTR 1 (Begin 01-Jul-99)	QTR 2 (Begin 01-Oct-99)	QTR 3 (Begin 01-Jan-00)	QTR 4 (Begin 01-Apr-00)
1. A-1 (1), North of WCGS	18.8 \pm 0.7	22.7 \pm 1.6	19.5 \pm 1.7	19.8 \pm 2.3
2. A-2, Sharpe	17.2 \pm 1.3	18.1 \pm 1.3	18.4 \pm 1.1	19.2 \pm 1.6
3. A-3, Forward staging area	16.6 \pm 1.3	20.0 \pm 1.8	22.2 \pm 2.3	16.2 \pm 1.3
4. B-1, East Sharpe	20.4 \pm 1.8	20.4 \pm 1.6	21.7 \pm 1.1	19.9 \pm 1.7
5. B-2, Waverly control	15.2 \pm1.5	21.8 \pm1.5	18.1 \pm2.1	21.2 \pm1.6
6. C-1, near residence	17.1 \pm 1.2	20.6 \pm 1.6	20.4 \pm 1.4	18.3 \pm 1.9
7. D-1 (9), near residence	15.2 \pm 0.9	19.1 \pm 1.7	16.5 \pm 1.1	15.3 \pm 2.4
8. E-1, near residence	17.8 \pm 0.8	20.2 \pm 2.1	19.6 \pm 2.6	17.9 \pm 1.6
9. F-1, near residence	18.5 \pm 2.1	20.3 \pm 1.3	18.3 \pm 1.7	19.1 \pm 2.0
10. G-1 (14), WCNOG gate	19.8 \pm 1.2	21.8 \pm 1.2	20.3 \pm 1.8	20.8 \pm 1.5
11. H-0 (42), CCL baffle dike A	12.1 \pm 1.0	14.9 \pm 1.2	13.4 \pm 0.9	12.8 \pm 1.3
12. H-1, East of CCL dam	17.9 \pm 1.0	21.5 \pm 1.7	17.2 \pm 1.5	17.6 \pm 1.3
13. H-2, LeRoy control	16.8 \pm1.1	19.0 \pm1.2	18.3 \pm1.3	15.5 \pm1.1
14. J-1, near residence	16.6 \pm 0.8	20.2 \pm 1.5	18.5 \pm 2.1	17.6 \pm 2.2
15. K-1 (29), near residence	13.8 \pm 1.6	14.8 \pm 1.1	14.0 \pm 1.0	13.6 \pm 1.6
16. L-1 (27), near residence	16.4 \pm 1.0	18.9 \pm 1.1	18.3 \pm 1.6	18.5 \pm 1.6
17. L-2, Burlington	19.2 \pm 1.0	21.5 \pm 2.0	18.0 \pm 2.6	16.4 \pm 1.9
18. L-3, Coffey County shop	15.0 \pm 1.3	20.5 \pm 1.5	17.8 \pm 1.1	17.3 \pm 1.2
19. M-1 (26), near residence	15.6 \pm 0.6	18.9 \pm 1.7	14.7 \pm 1.9	16.4 \pm 1.8
20. N-1, near pasture	20.8 \pm 1.1	22.2 \pm 1.7	19.4 \pm 1.7	20.5 \pm 1.2
21. P-0 (43), CCL baffle dike B	10.2 \pm 1.4	15.4 \pm 1.0	12.3 \pm 1.6	11.7 \pm 1.2
22. P-1, New Strawn	16.8 \pm 0.9	21.9 \pm 2.0	17.9 \pm 1.5	17.6 \pm 1.6
23. P-2 (40), Hartford control	14.7 \pm2.0	19.5 \pm1.2	16.5 \pm1.1	17.8 \pm1.1
24. P-3 (45), CCL entrance	17.4 \pm 0.7	20.8 \pm 1.4	20.6 \pm 0.9	17.0 \pm 1.3
25. P-4 (46), CCL near MUDS	18.3 \pm 1.7	20.2 \pm 1.8	21.9 \pm 2.0	16.7 \pm 3.0
26. P-5, JRR public use area	16.3 \pm 1.2	24.6 \pm 2.2	17.5 \pm 1.9	20.9 \pm 2.3
27. Q-1, near residence	17.9 \pm 1.2	21.9 \pm 1.3	18.7 \pm 1.1	17.9 \pm 1.2
28. R-0 (41), Stringtown cemetery	19.0 \pm 1.3	24.1 \pm 1.5	21.6 \pm 1.1	21.3 \pm 1.2
29. R-1 (37), near residence	17.5 \pm 1.7	19.3 \pm 2.2	19.2 \pm 1.9	14.9 \pm 1.4
30. R-2 (44), CCL EEA	18.2 \pm 1.6	22.5 \pm 2.2	18.5 \pm 1.9	19.2 \pm 1.9
31. R-3, near Coffey County airport	17.7 \pm 1.7	20.6 \pm 2.2	20.3 \pm 3.0	21.4 \pm 2.5

^a The total uncertainty is determined by the equation

$$s_{UNC} = \sqrt{s_{ran}^2 + 2\%s_{sys}^2}$$

where s_{ran} is the random uncertainty and s_{sys} is the systematic uncertainty associated with equipment and methods (determined by error propagation techniques). A ¹³⁷Cs energy calibration factor is determined for each TLD. See Figure 1 for sample location.

^b The Coffey County Lake (CCL) public access areas are the Environmental Education Area (EEA) in sector R, and the fishing area near the makeup discharge structure (MUDS) in sector P.

TABLE 2.1 Wolf Creek collocated quarterly direct radiation monitoring SFY 2000. Direct radiation monitoring results in mR. WCNOG results are expressed as normalized 90-day quarter average \pm two standard deviations of two dosimeters at each location (three TLD chips per badge are used for data evaluation). KDHE results are expressed as a normalized 90-day quarter average \pm total uncertainty (one standard deviation) of three TLD bulb dosimeters at each location.

Location KDHE (WCNOG)	Quarter begin	KDHE	WCNOG
1. A-1 (1)		18.8 \pm 0.7	22.3 \pm 1.0
		22.7 \pm 1.6	19.1 \pm 1.4
		19.5 \pm 1.7	17.6 \pm 0.9
		19.8 \pm 2.3	21.9 \pm 1.4
2. D-1(9)		15.2 \pm 0.9	22.2 \pm 3.9
		19.1 \pm 1.7	17.3 \pm 1.0
		16.5 \pm 1.1	14.5 \pm 0.9
		15.3 \pm 2.4	18.8 \pm 1.1
3. G-1 (14)		19.8 \pm 1.2	23.3 \pm 4.3
		21.8 \pm 1.2	18.9 \pm 0.9
		20.3 \pm 1.8	14.8 \pm 1.0
		20.8 \pm 1.5	21.1 \pm 1.4
4. H-0 (42)		12.1 \pm 1.0	14.7 \pm 1.4
		14.9 \pm 1.2	14.0 \pm 2.7
		13.4 \pm 0.9	11.5 \pm 1.1
		12.8 \pm 1.3	15.1 \pm 1.1
5. K-1 (29)		13.8 \pm 1.6	17.6 \pm 1.4
		14.8 \pm 1.1	15.1 \pm 1.2
		14.0 \pm 1.0	14.2 \pm 0.7
		13.6 \pm 1.6	17.3 \pm 1.9
6. L-1 (27)		16.4 \pm 1.0	24.3 \pm 1.0
		18.9 \pm 1.1	18.2 \pm 1.7
		18.3 \pm 1.6	18.1 \pm 5.1
		18.5 \pm 1.6	20.9 \pm 1.4
7. M-1 (26)	01-Jul-99	15.6 \pm 0.6	21.0 \pm 2.9
	01-Oct-99	18.9 \pm 1.7	18.9 \pm 3.2
	01-Jan-00	14.7 \pm 1.9	15.5 \pm 2.1
	01-Apr-00	16.4 \pm 1.8	19.5 \pm 1.6
8. P-0 (43)		10.2 \pm 1.4	14.2 \pm 1.7
		15.4 \pm 1.0	12.9 \pm 1.6
		12.3 \pm 1.6	11.2 \pm 0.8
		11.7 \pm 1.2	14.0 \pm 0.7
9. P-2 (40)		14.7 \pm 2.0	17.1 \pm 1.9
		19.5 \pm 1.2	15.7 \pm 1.1
		16.5 \pm 1.1	15.4 \pm 3.6
		17.8 \pm 1.1	17.6 \pm 1.6
10. P-3 (45)		17.4 \pm 0.7	22.5 \pm 1.3
		20.8 \pm 1.4	22.6 \pm 1.8
		20.6 \pm 0.9	17.3 \pm 0.9
		17.0 \pm 1.3	22.0 \pm 1.3
11. P-4 (46)		18.3 \pm 1.7	22.8 \pm 1.5
		20.2 \pm 1.8	21.0 \pm 4.6
		21.9 \pm 2.0	17.4 \pm 1.3
		16.7 \pm 3.0	20.0 \pm 0.9
12. R-0 (41)		19.0 \pm 1.3	20.3 \pm 2.4
		24.1 \pm 1.5	22.0 \pm 2.3
		21.6 \pm 1.1	17.0 \pm 3.6
		21.3 \pm 1.2	21.1 \pm 1.4
13. R-1 (37)		17.5 \pm 1.7	19.5 \pm 2.6
		19.3 \pm 2.2	17.7 \pm 1.3
		19.2 \pm 1.9	16.2 \pm 2.3
		14.9 \pm 1.4	19.3 \pm 1.0
14. R-2 (44)		18.2 \pm 1.6	20.8 \pm 2.0
		22.5 \pm 2.2	18.7 \pm 1.4
		18.5 \pm 1.9	18.0 \pm 0.9
		19.2 \pm 1.9	20.3 \pm 1.4

TABLE 3.0 Wolf Creek monthly samples for waterborne radionuclides surface water SFY 2000. Sample results in pCi/R. Results reported at the 95% confidence level. Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek operation were present above the lower limits of detection. Gamma emitting radionuclides routinely analyzed for include ^7Be , ^{40}K , ^{51}Cr , ^{54}Mn , ^{58}Co , ^{59}Fe , ^{60}Co , ^{65}Zn , ^{67}Ga , ^{95}Nb , ^{95}Zr , ^{99}Mo , $^{99\text{m}}\text{Tc}$, ^{103}Ru , ^{106}Ru , $^{110\text{m}}\text{Ag}$, ^{111}In , ^{123}I , ^{125}Sb , ^{131}I , ^{134}Cs , ^{137}Cs , ^{140}Ba , ^{140}La , ^{141}Ce , ^{144}Ce , ^{169}Yb , ^{226}Ra , ^{228}Ac , ^{228}Th , ^{234}Th , and ^{239}Np . See Figure 1 for sample locations. WCNOG sample location designations are denoted by parenthesis.

Date	J-1A (SP) ^a CCL near spillway	Q-1 (DC) CCL discharge cove	N-1 (MUSH) ^b John Redmond Reservoir below dam control
Tritium (^3H)			
28-Jul-99	11995 ±332	12184 ±335	<350
19-Aug-99	11374 ±326	11600 ±329	<350
16-Sep-99	11977 ±335	11516 ±330	<350
21-Oct-99	11249 ±327	11296 ±327	<350
18-Nov-99	10326 ±317	10404 ±225	<350
16-Dec-99	11986 ±335	10803 ±322	<350
20-Jan-00	11418 ±329	12540 ±341	<350
17-Feb-00	12396 ±347	12853 ±351	<350
23-Mar-00	12058 ±244	11875 ±343	<350
20-Apr-00	15624 ±379	15318 ±375	<350
18-May-00	16231 ±387	16108 ±386	<350
15-Jun-00	16678 ±391	15754 ±381	<350
Gross Alpha+Beta			
28-Jul-99	6 ±2	7 ±2	7 ±2
19-Aug-99	11 ±3	10 ±3	7 ±3
16-Sep-99	10 ±3	8 ±3	7 ±5
21-Oct-99	6 ±3	7 ±3	8 ±3
18-Nov-99	9 ±3	10 ±2	11 ±4
16-Dec-99	7 ±3	10 ±3	6 ±3
20-Jan-00	7 ±3	11 ±3	7 ±3
17-Feb-00	11 ±3	11 ±3	7 ±3
23-Mar-00	7 ±2	4 ±3	6 ±3
20-Apr-00	7 ±3	6 ±3	5 ±3
18-May-00	10 ±3	11 ±3	11 ±3
15-Jun-00	7 ±3	4 ±3	5 ±3

^a CCL denotes Coffey County Lake.

^b MUSH denotes makeup screen house.

TABLE 3.1 Wolf Creek monthly duplicate samples for waterborne radionuclides in surface water SFY 2000. Gamma isotopic analysis by both KDHE and WCNOG of surface water samples showed that no gamma emitters attributable to WCGS operation were present above the lower limits of detection. Sample results in pCi/R tritium (^3H).

Date	J-1A (SP)		Q-1 (DC)		N-1 (MUSH) control	
	KDHE	WCNOG	KDHE	WCNOG	KDHE	WCNOG
28-Jul-99	11995 \pm 332	11000 \pm 1000	12184 \pm 335	10000 \pm 1000	<350	<100
19-Aug-99	11374 \pm 326	11000 \pm 1000	11600 \pm 329	11000 \pm 1000	<350	<200
16-Sep-99	11977 \pm 335	11000 \pm 1000	11516 \pm 330	11000 \pm 1000	<350	<300
21-Oct-99	11249 \pm 327	11000 \pm 1000	11296 \pm 327	11000 \pm 1000	<350	<200
18-Nov-99	10326 \pm 317	10000 \pm 1000	10404 \pm 225	9600 \pm 300	<350	<200
16-Dec-99	11986 \pm 335	11000 \pm 1000	10803 \pm 322	11000 \pm 1000	<350	<300
20-Jan-00	11418 \pm 329	11000 \pm 1000	12540 \pm 341	11000 \pm 1000	<350	<200
17-Feb-00	12396 \pm 347	12000 \pm 1000	12853 \pm 351	11000 \pm 1000	<350	<200
23-Mar-00	12058 \pm 244	11000 \pm 1000	11875 \pm 343	12000 \pm 1000	<350	<200
20-Apr-00	15624 \pm 379	14000 \pm 1000	15318 \pm 375	13000 \pm 1000	<350	<200
18-May-00	16231 \pm 387	14000 \pm 1000	16108 \pm 386	13000 \pm 1000	<350	<200
15-Jun-00	16678 \pm 391	13000 \pm 1000	15754 \pm 381	13000 \pm 1000	<350	<200

TABLE 4.0 Wolf Creek annual samples for deposition of airborne radionuclides on surface water (PONDS) SFY 2000. Sample results in pCi/R. Results reported at the 95% confidence level. Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek operation were present above the lower limits of detection. Gamma emitting radionuclides routinely analyzed for include ^7Be , ^{40}K , ^{51}Cr , ^{54}Mn , ^{58}Co , ^{59}Fe , ^{60}Co , ^{65}Zn , ^{67}Ga , ^{95}Nb , ^{95}Zr , ^{99}Mo , $^{99\text{m}}\text{Tc}$, ^{103}Ru , ^{106}Ru , $^{110\text{m}}\text{Ag}$, ^{111}In , ^{123}I , ^{125}Sb , ^{131}I , ^{134}Cs , ^{137}Cs , ^{140}Ba , ^{140}La , ^{141}Ce , ^{144}Ce , ^{169}Yb , ^{226}Ra , ^{228}Ac , ^{228}Th , ^{234}Th , and ^{239}Np . See Figure 1 for sample locations. WCNOG sample location designations are denoted by parenthesis.

Location	Date	Gross alpha+beta	Tritium (^3H)
A-1, pond near Sharpe	29-Jun-00	6 \pm 2	<350
P-1, New Strawn City Lake	31-May-00	5 \pm 3	<350

TABLE 5.0 Wolf Creek quarterly duplicate samples for waterborne radionuclides in ground water SFY 2000. Sample results in pCi/L. Results reported at the 95% confidence level. Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek operation were present above the lower limits of detection. Gamma emitting radionuclides routinely analyzed for include ^7Be , ^{40}K , ^{51}Cr , ^{54}Mn , ^{58}Co , ^{59}Fe , ^{60}Co , ^{65}Zn , ^{67}Ga , ^{95}Nb , ^{95}Zr , ^{99}Mo , $^{99\text{m}}\text{Tc}$, ^{103}Ru , ^{106}Ru , $^{110\text{m}}\text{Ag}$, ^{111}In , ^{123}I , ^{125}Sb , ^{131}I , ^{134}Cs , ^{137}Cs , ^{140}Ba , ^{140}La , ^{141}Ce , ^{144}Ce , ^{169}Yb , ^{226}Ra , ^{228}Ac , ^{228}Th , ^{234}Th , and ^{239}Np . See Figure 1 for sample locations. WCNOG sample location designations are denoted by parenthesis.

Date	J-1 (D65)	L-2 (C49)	N-1 (C10)	B-1 (B12) Control
	KDHE (WCNOG) ^a	KDHE (WCNOG)	KDHE(WCNOG)	KDHE (WCNOG)
Tritium (^3H)				
19-Aug-99	<350 (<100)	<350 (<100)	<350 (<200)	<350 (<200)
18-Nov-99	<350 (<200)	<350 (<200)	<350 (<200)	<350 (<200)
17-Feb-00	<350 (<200)	<350 (<200)	<350 (<200)	<350 (<200)
18-May-00	<350 (<200)	<350 (<200)	<350 (<200)	<350 (<200)
Gross Alpha+Beta				
19-Aug-99	1 \pm 3	5 \pm 3	9 \pm 3	9 \pm 3
18-Nov-99	5 \pm 3	9 \pm 3	6 \pm 3	7 \pm 2
17-Feb-00	4 \pm 3	9 \pm 3	8 \pm 3	6 \pm 3
18-May-00	2 \pm 3	11 \pm 4	12 \pm 3	7 \pm 3

^a WCNOG results for tritium only.

TABLE 6.0 Wolf Creek ingestion pathway quarterly samples for waterborne radionuclides in drinking water SFY 2000. Sample results in pCi/l. Results reported at the 95% confidence level. Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek operation were present above the lower limits of detection. Gamma emitting radionuclides routinely analyzed for include ⁷Be, ⁴⁰K, ⁵¹Cr, ⁵⁴Mn, ⁵⁸Co, ⁵⁹Fe, ⁶⁰Co, ⁶⁵Zn, ⁶⁷Ga, ⁹⁵Nb, ⁹⁵Zr, ⁹⁹Mo, ^{99m}Tc, ¹⁰³Ru, ¹⁰⁶Ru, ^{110m}Ag, ¹¹¹In, ¹²³I, ¹²⁵Sb, ¹³¹I, ¹³⁴Cs, ¹³⁷Cs, ¹⁴⁰Ba, ¹⁴⁰La, ¹⁴¹Ce, ¹⁴⁴Ce, ¹⁶⁹Yb, ²²⁶Ra, ²²⁸Ac, ²²⁸Th, ²³⁴Th, and ²³⁹Np. See Figure 1 for sample locations. WCNOG sample location designations are denoted by parenthesis.

Date	Gross alpha + beta	Tritium (³ H)
LeRoy (LW40) ^a		
Public water supply composite (three monthly grab samples) collected at LeRoy for quarterly analysis		
30-Sep-99	1±2	<350
22-Dec-99	<4	<350
23-Mar-00	4±3	<350
29-Jun-00	4±3	<350
Composite collected at LeRoy (150 mℓ every 12 h) for monthly analysis		
A quarterly composite of monthly samples is analyzed by the Environmental Protection Agency National Air and Radiation Laboratory		
	KDHE (WCNOG)	KDHE (WCNOG)
28-Jul-99	2±2 (7±1)	<350
26-Aug-99	9±3 (7±1)	<350
30-Sep-99	5±3 (5±1)	<350 (<300)
28-Oct-99	5±2 (5±1)	<350
24-Nov-99	4±2 (20±4)	<350
22-Dec-99	8±3 (6±1)	<350 (<200)
27-Jan-00	5±3 (7±1)	<350
24-Feb-00	3±2 (6±1)	<350
23-Mar-00	3±3 (5±1)	<350 (<300)
27-Apr-00	4±2 (5±1)	<350
25-May-00	3±2 (5±1)	<350
29-Jun-00	<4 (5±1)	<350 (<200)
Burlington (BW15) ^b		
Public water supply composite (three monthly grab samples) collected at Burlington for quarterly analysis		
Control		
	KDHE (WCNOG)	KDHE (WCNOG)
13-Sep-99	3±2 (5±2)	<350 (<300)
07-Dec-99	1±1 (10±2)	<350 (<200)
06-Mar-00	4±3 (6±1)	<350 (<200)
08-May-00	5±3 (5±1)	<350 (<200)

^a Annual composite strontium analysis showed <1 pCi/l ⁸⁹Sr and <1 pCi/l ⁹⁰Sr. The isotopes ⁸⁹Sr and ⁹⁰Sr are betaemitters. This site is collocated with WCNOG. KDHE collects monthly grab samples for quarterly analysis at this location as well as a quarterly sample from a composite water sampler. The WCNOG water sampler is set at a nominal compositing rate of 10 mℓ every hour for monthly collection and analysis of gross beta and quarterly analysis of a composite of three monthly samples for tritium.

^b This site is also collocated with WCNOG. KDHE only collects monthly grab samples for quarterly analysis at this location. WCNOG also has a composite water sampler at this location. The WCNOG gross beta result is an average of three monthly sample results. Annual composite strontium analysis showed <1 pCi/l ⁸⁹Sr and <1 pCi/l ⁹⁰Sr.

TABLE 7.0 Wolf Creek ingestion pathway samples for radionuclide bio-accumulation in milk (from airborne radionuclide deposition on pasturage with subsequent ingestion by milk producing cattle) SFY 2000. Sample is collected at Lebo, R-1. Lebo is a control location. Sample results in pCi/l. Results reported at the 95% confidence level. Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek operation were present above the lower limits of detection. Gamma emitting radionuclides routinely analyzed for include ^7Be , ^{40}K , ^{51}Cr , ^{54}Mn , ^{58}Co , ^{59}Fe , ^{60}Co , ^{65}Zn , ^{67}Ga , ^{95}Nb , ^{95}Zr , ^{99}Mo , $^{99\text{m}}\text{Tc}$, ^{103}Ru , ^{106}Ru , $^{110\text{m}}\text{Ag}$, ^{111}In , ^{123}I , ^{125}Sb , ^{131}I , ^{134}Cs , ^{137}Cs , ^{140}Ba , ^{140}La , ^{141}Ce , ^{144}Ce , ^{169}Yb , ^{226}Ra , ^{228}Ac , ^{228}Th , ^{234}Th , and ^{239}Np . See Figure 1 for sample location.

Date	^{40}K , natural KDHE (WCNOC)
Lebo R-1 quarterly sample collection	
01-Jul-99	1385 ± 121
07-Oct-99	892 ± 212
06-Jan-00	1503 ± 131
27-Apr-00	1374 ± 123

^a Annual strontium analysis showed <2 pCi/l ^{89}Sr and <2 pCi/l ^{90}Sr . The isotopes ^{89}Sr and ^{90}Sr are beta emitters.

TABLE 8.0 Wolf Creek semiannual samples for airborne radionuclide deposition on soil SFY 2000. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. The presence of ^{137}Cs should not be attributed to Wolf Creek operation unless accompanied by other reactor nuclides. Gamma emitting radionuclides routinely analyzed for include ^7Be , ^{40}K , ^{51}Cr , ^{54}Mn , ^{58}Co , ^{59}Fe , ^{60}Co , ^{65}Zn , ^{67}Ga , ^{95}Nb , ^{95}Zr , ^{99}Mo , $^{99\text{m}}\text{Tc}$, ^{103}Ru , ^{106}Ru , $^{110\text{m}}\text{Ag}$, ^{111}In , ^{123}I , ^{125}Sb , ^{131}I , ^{134}Cs , ^{137}Cs , ^{140}Ba , ^{140}La , ^{141}Ce , ^{144}Ce , ^{169}Yb , ^{226}Ra , ^{228}Ac , ^{228}Th , ^{234}Th , and ^{239}Np . The isotopes ^{89}Sr and ^{90}Sr are beta emitters. Strontium analysis is done on selected samples. The symbol U indicates naturally occurring radioisotopes. See Figure 2 for sample location. WCNO sample location designations are denoted by parenthesis.

Isotope	A-1 Sector A, Sharpe KDHE (WCNO)		E-1 Scott Valley Church Control		H-1 East of CCL ^a dam, near WCA H-1	
	20-Oct-99 0.25 m ²	30-Nov-99 0.25 m ²	30-Nov-99 0.07 m ²	31-May-00 0.014 m ²	30-Nov-99 0.07 m ²	08-Jun-00 0.11 m ²
^{228}AcU	1278 ±75(not reported)	1363 ±95	1683 ±117	1700 ±119	1573 ±106	1772 ±156
^7BeU	502±50 (<300)	<346	<346	<346	<346	540 ±85
^{137}Cs	116±9 (124±29)	399 ±30	673 ±51	598 ±51	334 ±26	203 ±20
^{40}KU	10850±737 (9210±920)	13754 ±1560	17612 ±1283	16416 ±1265	13221 ±1033	14184 ±1885
^{226}RaU	2664±288 (1800±530)	3006 ±351	3637 ±424	4164 ±827	3790 ±440	3975 ±766
^{228}ThU	2406±30071(1140±110)	2693 ±41685	5745 ±71821	3508 ±44761	3649 ±53132	2688 ±30823
Isotope	P-1 (MUDS) CCL public access area for fishing		R-1 (EEA) CCL environmental education area			
	30-Nov-99 0.20 m ² KDHE (WCNO)	13-Jun-00 0.25 m ² KDHE (WCNO)	30-Nov-99 0.11 m ² KDHE(WCNO)	12-Jun-00 0.25 m ² KDHE(WCNO)		
^{228}AcU	1493 ±101 (not reported)	2162 ±154 (not reported)	1361 ±94 (not reported)	1270 ±95 (not reported)		
^7BeU	<346 (<300)	386 ±75 (<500)	<346 (<350)	<346 (<350)		
^{137}Cs	409 ±32 (404 ±40)	43 ±7 (<50)	224 ±19 (187 ±28)	143 ±14(168 ±24)		
^{40}KU	13210 ±963 (11000 ±1100)	12258 ±957 (9720 ±970)	14256 ±1037 (11500 ±1200)	11797 ±918 (12100 ±1200)		
^{226}RaU	3056 ±335 (1800 ±380)	5353 ±928 (2880 ±670)	2952 ±325 (1500 ±520)	3128 ±559 (2650 ±500)		
^{228}ThU	<859 (1120 ±110)	3995 ±49444 (1580 ±160)	2420 ±30250 (1010 ±100)	2482 ±31031 (1170 ±120)		

^a Coffey County Lake.

TABLE 9.0 Wolf Creek semiannual samples for waterborne radioisotope concentration in bottom sediments SFY 2000. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. Gamma emitting radionuclides routinely analyzed for include ^7Be , ^{40}K , ^{51}Cr , ^{54}Mn , ^{58}Co , ^{59}Fe , ^{60}Co , ^{65}Zn , ^{67}Ga , ^{95}Nb , ^{95}Zr , ^{99}Mo , $^{99\text{m}}\text{Tc}$, ^{103}Ru , ^{106}Ru , $^{110\text{m}}\text{Ag}$, ^{111}In , ^{123}I , ^{125}Sb , ^{131}I , ^{134}Cs , ^{137}Cs , ^{140}Ba , ^{140}La , ^{141}Ce , ^{144}Ce , ^{169}Yb , ^{226}Ra , ^{228}Ac , ^{228}Th , ^{234}Th , and ^{239}Np . The isotopes ^{89}Sr and ^{90}Sr are beta emitters. Strontium analysis is done on selected samples. The symbol \bar{U} indicates naturally occurring radioisotopes. See Figure 2 for sample location. WCNO sample location designations are denoted by parenthesis.

Isotope	A.-1 Pond near Sharpe	J-1 Wolf Creek below CCL spillway	
	29-Jun-00	13-Oct-99 KDHE	07-Jun-00 KDHE
²²⁸ AcU	1087 ±81	1854 ±107	1293 ±96
⁷ BeU	<346	398 ±50	<346
¹³⁷ Cs	<49	<49	<49
⁴⁰ KU	8842 ±695	14555 ±990	12037 ±935
²²⁶ RaU	2335 ±436	4419 ±441	3080 ±563
²²⁸ ThU	2061 ±25765	3393 ±42409	2151 ±26892
Isotope	N-1 (JRR) John Redmond Reservoir Control		
	01-Oct-99 KDHE (WCNOC)	25-Apr-00 KDHE (WCNOC)	
²²⁸ AcU	1719 ±121 (not reported)	1721 ±167 (not reported)	
⁷ BeU	676 ±87 (538 ±245)	817 ±128 (1040 ±350)	
¹³⁷ Cs	203 ±18 (129 ±28)	186 ±20 (161 ±26)	
⁴⁰ KU	20184 ±1536 (15900±1600)	19683 ±2959 (15000 ±1500)	
²²⁶ RaU	3575 ±430 (2180 ±600)	3089 ±668 (1700 ±500)	
²²⁸ ThU	3472 ±53567 (1430 ±140)	3853 ±48172 (1240 ±120)	
Isotope	Q-1 (DC) CCL discharge cove		
	01-Oct-99 KDHE (WCNOC)	18-Apr-00 KDHE (WCNOC)	
²²⁸ AcU	1739 ±102 (not reported)	1765 ±140 (not reported)	
⁷ BeU	514 ±59 (687 ±264)	<346 (<600)	
⁶⁰ Co	816 ±37 (663 ±66)	687 ±38 (549 ±62)	
¹³⁷ Cs	426 ±29 (307 ±31)	377 ±36 (305 ±50)	
⁴⁰ KU	16586 ±1124 (11800 ±1200)	15309 ±1238 (11100 ±1100)	
²²⁶ RaU	3638 ±395 (2460 ±620)	3762 ±765 (2570 ±720)	
¹²⁵ Sb	258 ±24 (not reported)	204 ±37 (not reported)	
⁸⁹ Sr	<200 (not analyzed)	<200 (not analyzed)	
⁹⁰ Sr	550 ±100 (not analyzed)	<200 (not analyzed)	
²²⁸ ThU	3324 ±41559 (1130 ±110)	3326 ±41584 (1290 ±130)	

TABLE 10.0 Wolf Creek semiannual samples for waterborne radioisotope concentration in shoreline sediment SFY 2000. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. Gamma emitting radionuclides routinely analyzed for include ⁷Be, ⁴⁰K, ⁵¹Cr, ⁵⁴Mn, ⁵⁸Co, ⁵⁹Fe, ⁶⁰Co, ⁶⁵Zn, ⁶⁷Ga, ⁹⁵Nb, ⁹⁵Zr, ⁹⁹Mo, ^{99m}Tc, ¹⁰³Ru, ¹⁰⁶Ru, ^{110m}Ag, ¹¹¹In, ¹²³I, ¹²⁵Sb, ¹³¹I, ¹³⁴Cs, ¹³⁷Cs, ¹⁴⁰Ba, ¹⁴⁰La, ¹⁴¹Ce, ¹⁴⁴Ce, ¹⁶⁹Yb, ²²⁶Ra, ²²⁸Ac, ²²⁸Th, ²³⁴Th, and ²³⁹Np. The isotopes ⁸⁹Sr and ⁹⁰Sr are beta emitters. Strontium analysis is done on selected samples. The symbol U indicates naturally occurring radioisotopes. See Figure 2 for sample location. WCNO sample location designations denoted by parenthesis.

Isotope	N-1 (JRR) John Redmond Reservoir Control		P-1 (MUDS) CCL public access area for fishing	
	25-Apr-00 KDHE (WCNO)		30-Nov-99 KDHE (WCNO)	12-Jun-00 KDHE (WCNO)
²²⁸ AcU ⁷ BeU ¹³⁷ Cs ⁴⁰ KU ²²⁶ Ra ¹²⁵ Sb ⁸⁹ Sr ⁹⁰ Sr ²²⁸ Th	1597 ±116 (not reported) 357 ±62 (<600) 66 ±27 (<50) 9489 ±748 (9610 ±960) 3461 ±616 (4520 ±740) <97 not analyzed not analyzed 2676 ±33447 (1910 ±190)		1749 ±105 (not reported) <346 (<300) <49 (<40) 11833 ±821 (9800 ±980) 4111 ±415 (2730 ±490) <97 (not reported) not analyzed not analyzed 3567 ±44591 (1530 ±150)	1600 ±116 (not reported) <346 (<400) 680 ±200 (<40) 11392 ±886 (9580 ±960) 3739 ±678 (3190 ±500) 140 ±23 (not reported) <200 (not analyzed) <200 (not analyzed) 3134 ±39182 (1340 ±130)
Isotope	Q-1 (DC) CCL discharge cove		R-1 (EEA) CCL environmental education area	
	01-Oct-99 KDHE (WCNO)	18-Apr-00 KDHE (WCNO)	30-Nov-99 KDHE (WCNO)	14-Jun-00 KDHE (WCNO)
²²⁸ AcU ⁷ BeU ¹³⁷ Cs ⁴⁰ KU ²²⁶ Ra ⁸⁹ Sr ⁹⁰ Sr ²²⁸ Th	1248 ±102 (not reported) 1837 ±206 (1520 ±300) 94 ±10 (89 ±33) 10236 ±790 (9000 ±900) 3473 ±468 (2060 ±540) <200 (not analyzed) 500 ±100 (not analyzed) 2068 ±25853 (1080 ±110)	1586 ±134 (not reported) <346 (<600) <49 (<50) 12382 ±1586 (11800 ±1200) 3428 ±652 (2760 ±780) not analyzed not analyzed 3378 ±42228 (1330 ±130)	1265 ±91 (not reported) 373 ±56 (<300) 282 ±22 (286 ±39) 12413 ±1000 (11000 ±1100) 2986 ±354 (1820 ±570) not analyzed not analyzed 3433 ±51565 (1040 ±100)	1275 ±116 (not reported) 247 ±59 (868 ±426) 261 ±24 (264 ±52) 13873 ±1824 (12000 ±1200) 3220 ±628 (2320 ±730) not analyzed not analyzed 3241 ±44546 (1110 ±110)

TABLE 11.0 Wolf Creek fish ingestion pathway duplicate samples for waterborne radioisotope bio-accumulation in fish SFY 2000. Sample results in pCi/kg-wet. Results reported at the 95% confidence level. Gamma emitting radionuclides routinely analyzed for include ^7Be , ^{40}K , ^{51}Cr , ^{54}Mn , ^{58}Co , ^{59}Fe , ^{60}Co , ^{65}Zn , ^{67}Ga , ^{95}Nb , ^{95}Zr , ^{99}Mo , $^{99\text{m}}\text{Tc}$, ^{103}Ru , ^{106}Ru , $^{110\text{m}}\text{Ag}$, ^{111}In , ^{123}I , ^{125}Sb , ^{131}I , ^{134}Cs , ^{137}Cs , ^{140}Ba , ^{140}La , ^{141}Ce , ^{144}Ce , ^{169}Yb , ^{226}Ra , ^{228}Ac , ^{228}Th , ^{234}Th , and ^{239}Np . A Tritium (^3H) in tissue analysis is done on all edible fish portions collected. ^3H is a beta emitter. See Figure 2 for sample locations. WCNOG sample location designations are denoted by parenthesis.

Location	Date	Description ^c	Isotope	
			^{40}K , natural KDHE (WCNOG)	^3H KDHE (WCNOG)
G-1 (UHS) CCL ^a ultimate heat sink	12-Oct-99	Wiper (4) SM Buffalo (1) Walleye (7) ^b	3885 ±722 (3590 ±360) 3259 ±312 (2520 ±250) 3847 ±468 (3320 ±370)	6137 ±1177(3200±200) 9255 ±1209 (5200±200) 8544 ±1200 (4600±200)
N-1 (JRR) John Redmond Reservoir below dam on Neosho River Control	01-Oct-99	Drum (2) Ch. Catfish (3) White Crappie (4)	4304 ±496 (3330 ±330) 4020 ±989 (3110 ±310) 4182 ±367 (3330 ±330)	<1200 (<300) <1200 (<300) <1200 (<300)
	25-Apr-00	White Crappie (5) Common Carp (2) LM Bass (4) Ch. Catfish (1)	4388 ±417(3390 ±340) 4126 ±513 (3750 ±380) 4075 ±1340 (2980 ±300) 4159 ±528 (3390 ±340)	<1200 (<200) <1200 (<200) <1200 (<200) <1200 (<200)
Q-1 (DC) CCL discharge cove	12-Oct-99	White Bass (6) Ch. Catfish (3) Common Carp (3)	3839 ±439 (3360 ±340) 3606 ±945 (2960 ±300) 3773 ±352 (3040 ±300)	6673 ±1181 (5500 ±300) 6459 ±1183 4500 ±200) 7040 ±1190 3600 ±200)
	18-Apr-00	Wiper (2) SM Buffalo (2) Ch. Catfish (6) White Bass (7) LM Bass (4)	4750 ±1515 (3640 ±360) 4264 ±383 (2790 ±280) 4388 ±394 (3240 ±320) 3785 ±472 (1990 ±200) 4903 ±1690 (3420 ±340)	7696 ±1244 (7700 ±300) 11003 ±1277 (7100 ±300) 8865 ±1256 (7000 ±300) 7668 ±1241 (220 ±110) 7778 ±1243 (6400 ±300)

^a Coffey County Lake.

^b WCNOG reported ^{137}Cs at 41 ± 16 pCi/kg-wet, KDHE reported < 32 pCi/kg-wet ^{137}Cs .

^c Species names as follows: Common Carp (*Cyprinus carpio*), Channel Catfish (*Ictalurus punctatus*), Large-mouth Bass (*Micropterus salmoides*), Walleye (*Stizostedion vitreum*), Wiper (hybrid) (*Morone chrysops* x *M. saxatilis*), White Bass (*Morone chrysops*), White Crappie (*Pomoxis annularis*)

TABLE 12.0 Wolf Creek samples for waterborne radioisotope bioaccumulation in aquatic vegetation SFY 2000. Sample results in pCi/kg-dry (KDHE) and pCi/kg-wet (WCNOC). Results reported at the 95% confidence level. Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek operation were present above the lower limits of detection. Gamma emitting radionuclides routinely analyzed for include ^7Be , ^{40}K , ^{51}Cr , ^{54}Mn , ^{58}Co , ^{59}Fe , ^{60}Co , ^{65}Zn , ^{67}Ga , ^{95}Nb , ^{95}Zr , ^{99}Mo , $^{99\text{m}}\text{Tc}$, ^{103}Ru , ^{106}Ru , $^{110\text{m}}\text{Ag}$, ^{111}In , ^{123}I , ^{125}Sb , ^{131}I , ^{134}Cs , ^{137}Cs , ^{140}Ba , ^{140}La , ^{141}Ce , ^{144}Ce , ^{169}Yb , ^{226}Ra , ^{228}Ac , ^{228}Th , ^{234}Th , and ^{239}Np . The isotopes ^{89}Sr and ^{90}Sr are beta emitters. Strontium analysis is done on selected samples. The symbol \bar{U} indicates naturally occurring radioisotopes. See Figure 2 for sample location. WCNOC sample location designations are denoted by parenthesis.

Isotope	J-1 Wolf Creek below CCL spillway Arrowhead (<i>Sagittaria latifolia</i>) 08-Jun-00	N-1 JRR East boat ramp <i>Algae</i> 08-Jun-00
$^7\text{Be}\bar{U}$ $^{40}\text{K}\bar{U}$ $^{226}\text{Ra}\bar{U}$ $^{228}\text{Th}\bar{U}$	2305 \pm 588 66793 \pm 12484 <90 <454	762 \pm 322 12403 \pm 3109 1059 \pm 851 2531 \pm 108472
Isotope	Q-1 (DC) CCL discharge cove <i>Algae</i> Near DC boat ramp 18-Apr-00 KDHE (WCNOC)	P-1 (MUDS) CCL Public Access Area <i>Algae</i> 12-Jun-00 KDHE (WCNOC)
$^{228}\text{Ac}\bar{U}$ $^7\text{Be}\bar{U}$ ^{58}Co ^{60}Co ^{134}Cs ^{137}Cs $^{40}\text{K}\bar{U}$ ^{54}Mn $^{226}\text{Ra}\bar{U}$ ^{89}Sr ^{90}Sr $^{228}\text{Th}\bar{U}$	830 \pm 93 (not reported) 831 \pm 151 (1110 \pm 140) <92 (22\pm11) 143 \pm16 (154 \pm17) <57 (44\pm15) 98 \pm16 (95 \pm14) 6443 \pm 707 (5190 \pm 520) <72 (<20) 1715 \pm 419 (1560 \pm 260) <500 (not analyzed) 600 \pm100 (not analyzed) 1844 \pm 23059 (655 \pm 66)	1024 \pm 86 (not reported) 806 \pm 132 (478 \pm 48) <92 (<5) <79 (11 \pm4) <57 (<7) <80 (11 \pm4) 20806 \pm 1657 (5250 \pm 530) <72 (<5) 1950 \pm 536 (453 \pm 81) not analyzed not analyzed 1766 \pm 22082 (263 \pm 26)
	WET/DRY = 2.5	WET/DRY = 5.6
Isotope	Q-1 (DC) CCL discharge cove 01-Oct-99 KDHE (WCNOC) American Lotus (<i>Nymphaealis lutea</i>)	R-1 (EEA) CCL environmental education area 14-Jun-00 KDHE (WCNOC) <i>Duckweed(Lemna minor), Arrowhead (Sagittaria latifolia) composite</i>
$^{228}\text{Ac}\bar{U}$ $^7\text{Be}\bar{U}$ ^{137}Cs $^{40}\text{K}\bar{U}$ $^{226}\text{Ra}\bar{U}$ $^{228}\text{Th}\bar{U}$	not reported 10243 \pm 981 (2260 230) <80 (<8) 10526 \pm 1897 (2090 210) 1442 \pm 527 (229 11) 3991 \pm 49910 (<10)	976 \pm 110 (not reported) 1087 \pm 154 (456 \pm 46) 172 \pm19 (69 \pm7) 15248 \pm 4836 (4770 \pm 480) 1971 \pm 421 (541 \pm 78) 3108 \pm 38860 (314 \pm 31)
	WET/DRY = 5.8	WET/DRY = 3.9

TABLE 13.0 Wolf Creek samples for airborne radionuclide deposition on terrestrial vegetation (with ingestion pathway sampling of garden vegetables and includes sampling for waterborne radionuclide bio-accumulation in irrigated crops) SFY 2000. Sample results in pCi/kg-dry (KDHE) and pCi/kg-wet (WCNOC). Results reported at the 95% confidence level. Gamma emitting radionuclides routinely analyzed for include ⁷Be, ⁴⁰K, ⁵¹Cr, ⁵⁴Mn, ⁵⁸Co, ⁵⁹Fe, ⁶⁰Co, ⁶⁵Zn, ⁶⁷Ga, ⁹⁵Nb, ⁹⁵Zr, ⁹⁹Mo, ^{99m}Tc, ¹⁰³Ru, ¹⁰⁶Ru, ^{110m}Ag, ¹¹¹In, ¹²³I, ¹²⁵Sb, ¹³¹I, ¹³⁴Cs, ¹³⁷Cs, ¹⁴⁰Ba, ¹⁴⁰La, ¹⁴¹Ce, ¹⁴⁴Ce, ¹⁶⁹Yb, ²²⁶Ra, ²²⁸Ac, ²²⁸Th, ²³⁴Th, and ²³⁹Np. The isotopes ⁸⁹Sr and ⁹⁰Sr are beta emitters. Strontium analysis is done on selected samples. See Figure 2 for sample location. WCNOC sample location designations are denoted by parenthesis.

Location	Date	Description	Isotope	
			⁷ Be natural KDHE (WCNOC)	⁴⁰ K natural KDHE (WCNOC)
A-1 Sector A, Sharpe/ Milo	30-Sep-99	Milo (Sorghum) whole upper plant, 6 plants	6235 ±616	9629 ±1699
A-1 Sector A, Sharpe/Pasture near Sharpe	08-Jun-00	Pasturage, 1.43 m ²	4515 ±644	32583 ±4560
A-2 Field west of EEA Wetlands area	12-Oct-99	Soybeans ^b , all plant parts except roots, 2.2 m ²	3141 ±372	9663 ±1005
E-1 Scott Valley Church Control	30-Nov-99	Pasturage, 0.68 m ²	10914 ±1115	6918 ±1196
	31-May-00	Pasturage, 2.2 m ²	6759 ±817	13744 ±1504
E-2 Garden in Sector E	28-Jul-99	Corn/ squash leaves, 2.2 m ²	7921 ±720 (2360 ±240)	34299 ±2597 (7450 ±750)
H-1 East of CCL dam, near WCA H-1	30-Nov-99	Pasturage, 0.68 m ²	17363 ±1522	2144 ±665
	08-Jun-00	Pasturage, 0.68 m ²	8835 ±1057	17375 ±1811
J-1 (NR-D1) Near LeRoy, crops irrigated with water from the Neosho River below the confluence with Wolf Creek	03-Nov-99	Corn Collected by WCNOC	<35 (<50)	2696 ±245 (2690 ±270)
J-2 (NR-D2) Near LeRoy, crops that may be irrigated (but were not) with water from the Neosho River below the confluence with Wolf Creek	03-Nov-99	Corn Collected by WCNOC	<35 (<40)	2681 ±36 (2870 ±290)
		Soybeans Collected by WCNOC	<35 (<50)	13142 ±951 (15000 ±1500)
K-1 (NR-U1) Control, near Burlington, crops irrigated with water from the Neosho River above the confluence with Wolf Creek	03-Nov-99	Corn Collected by WCNOC	<35 (<40)	2613 ±239 (2940 ±290)
P-1 (MUDS) CCL public access area, north side of parking lot, 10 m from shore	30-Nov-99	Pasturage, 1.43 m ² (WET/DRY = 2.1)	9978 ±967 (19300 ±1900)	17592 ±3179 (1030 ±300)
	12-Jun-00	Pasturage, 2.2 m ² (WET/DRY = 2.6)	7400 ±974 (1400 ±140)	15311 ±3971 (4290 ±430)
Q-1 Wheat field, 17 th and Milo Road	08-Jun-00	Wheat, raw ready to harvest, no roots, 1.21 m ²	1453 ±257	6978 ±963
R-1 (EEA) CCL environmental education area	20-Oct-99	Pasturage, 1.44 m ² (WET/DRY = 2.4)	11410 ±1249 (4720 ±470)	34736 ±3143 (13900 ±1400)
	12-Jun-00	Pasturage, 2.2 m ² (WET/DRY = 3.8)	1173 ±216 (357 ±108)	20700 ±1852 (4270 ±430)

^a KDHE also reported 1052 ±223 pCi/kg-dry ²²⁶Ra.

TABLE I4.0 KDHE radiochemistry laboratory method detection limits SFY 2000. Listed below are method detection limits of present analytical methods for some of the radionuclides monitored by the Radiochemistry Laboratory of KDHE. These limits are intended as guides to order of magnitude sensitivities and are calculated with a 95% level of confidence (activity will be detected 95% of the time if it is present).

GeLi [HPGe] detection system ^a						
Environmental sampling						
	Water and milk	Filter	Wipe	Soil and sediment	Biota	Vegetation and food products
Minimum sample size	2000 mL	1500 m ³	Total	0.45 kg	0.3 kg	1 kg
Minimum counting time	8 hr	3 hr	3 hr	15 hr	15 hr	15 hr
Method detection limit	pCi/L	pCi/m ³	pCi/wipe	pCi/kg-dry	pCi/kg-wet	pCi/kg-dry
⁷ Be	64 [22]	0.03 [0.02]	****	346 [186]	231 [144]	35 [19]
⁴⁰ K	88 [39]	0.03 [0.02]	****	828 [654]	459 [262]	152 [72]
⁵¹ Cr	52 [32]	0.01 [0.009]	5 [3]	35 [22]	41 [32]	55 [46]
⁵⁴ Mn	4 [2]	0.004 [0.003]	1 [0.7]	44 [11]	30 [15]	72 [24]
⁵⁸ Co	4 [2]	0.008 [0.002]	2 [1]	45 [23]	37 [20]	92 [36]
⁵⁹ Fe	8 [3]	0.01 [0.01]	3 [2]	51 [16]	41 [15]	97 [52]
⁶⁰ Co	11 [7]	0.01 [0.0053]	2.5 [1.7]	56 [35]	43 [26]	79 [50]
⁶⁵ Zn	8 [4]	0.01 [0.007]	****	48 [30]	38 [22]	93 [63]
⁹⁵ Nb	7 [3]	0.009 [0.007]	2.5 [1.4]	68 [30]	44 [26]	9 [4]
⁹⁵ Zr	6 [3]	0.01 [0.002]	0.5 [0.3]	35 [27]	27 [19]	84 [54]
⁹⁹ Mo	5 [3]	0.002 [0.0014]	1 [0.6]	73 [43]	33 [21]	****
¹⁰³ Ru	10 [7]	0.004 [0.003]	****	29 [20]	29 [21]	69 [47]
¹⁰⁶ Ru	55 [43]	0.07 [0.05]	1.5 [1]	269 [192]	43 [29]	96 [65]
^{110m} Ag	4 [3]	0.006 [0.0002]	****	47 [33]	47 [34]	86 [55]
¹²⁵ Sb	35 [12]	0.02 [0.01]	****	97 [44]	96 [51]	15 [6]
¹³¹ I	5 [3] (1) ^b	0.00027 [0.00027] ^c	1.5 [1]	33 [20]	37 [23]	45 [13]
¹³⁴ Cs	5 [3]	0.007 [0.004]	1.4 [1]	44 [29]	37 [24]	57 [39]
¹³⁷ Cs	7 [4]	0.006 [0.004]	1 [0.3]	49 [29]	32 [21]	80 [56]
¹⁴⁰ Ba	10 [6]	0.004 [0.003]	****	26 [17]	24 [15]	60 [39]
¹⁴⁰ La	9 [5]	0.01 [0.02]	****	28 [9]	34 [21]	13 [6]
¹⁴¹ Ce	8 [3]	0.002 [0.001]	****	46 [23]	22 [13]	6 [3]
¹⁴⁴ Ce	35 [14]	0.013 [0.0096]	****	216 [103]	110 [70]	28 [14]
²²⁶ Ra	116 [69]	0.05 [0.03]	****	828 [654]	323 [195]	90 [51]
²²⁸ Ac	30 [18] 15 h	0.0127 [0.0099]	****	68 [33]	146 [87]	27 [12]
²²⁸ Th	387 [142]	0.09 [0.06]	****	859 [317]	944 [356]	454 [167]
²³⁴ Th	618 [87] 15 h	0.159 [0.423]	****	1009 [378]	1300 [556]	570 [94]
²³⁵ U	****	****	45 [30] 15 h	****	****	****
²³⁹ Np	41 [33]	0.01 [0.009]	5 [3]	64 [44]	40 [30]	97 [71]
Hospital effluent						
	Water	Filter	Wipe			
Minimum sample size	500 mL	1500 m ³	Total			
Minimum counting time	8 hr	3 hr	3 hr			
Method detection limit	pCi/L	pCi/m ³	pCi/wipe			
⁶⁷ Ga	30 [17]	****	19 [17]			
^{99m} Tc	10 [7]	0.002 [0.0012]	0.7 [0.4]			
¹¹¹ In	11 [6]	0.002 [0.0014]	0.5 [0.35]			
¹²³ I	10 [6]	****	****			
¹⁶⁹ Yb	28 [19]	0.003 [0.0021]	0.7 [0.39]			

^a GeLi = Germanium lithium; HPGe = High purity germanium.

^b Two methods of analysis are done: **1)** 8 hour direct gamma isotopic analysis of a 2000 mL milk or water sample that has a method detection limit (MDL) of 3 pCi/L, and **2)** 3 hour gamma isotopic analysis of ion exchange resin after a 1500 mL milk sample is filtered through an ion exchange column that has an MDL of 1 pCi/L.

^c The MDL for ¹³¹I when analyzing a charcoal cartridge is 0.03 [0.02] pCi/m³ based upon a 250 m³ sample volume. If the sample volume is increased to 1500 m³, the MDL is 0.002 [0.001] pCi/m³.

TABLE I4.0, continued KDHE radiochemistry laboratory method detection limits SFY 2000. Listed below are method detection limits of present analytical methods for some of the radionuclides monitored by the Radiochemistry Laboratory of KDHE. These limits are intended as guides to order of magnitude sensitivities and are calculated with a 95% level of confidence (activity will be detected 95% of the time if it is present).

Low background alpha and beta counting system					
	Water	Milk	Wipe	Soil and sediment	Vegetation and food products
Minimum sample size	1000 mL	1000 mL	Total	0.01 kg	0.1 kg
Minimum counting time	200 min.	200 min.	200 min.	200 min.	200 min.
Method detection limit	pCi/L	pCi/L	pCi/wipe	pCi/kg-dry	pCi/kg-dry
⁸⁹ Sr	1	2	3	200	500
⁹⁰ Sr	1	2	4	200	500
¹³¹ I	1	****	****	****	****
²²⁸ Ra	1.2	****	0.3	60	****
Gross beta					
	Water		Filter		Wipe
Minimum sample size	200 mL		250 mL		Total
Minimum counting time	200 min.		100 min.		100 min.
Method detection limit	4 pCi/L		0.004 pCi/mL		2 pCi/wipe
Internal proportional counter					
	Water		Wipe		Soil and sediment
Minimum sample size	1000 mL		Total		0.01 kg
Minimum counting time	100 min.		200 min.		200 min.
Method detection limit	pCi/L		pCi/wipe		pCi/kg-dry
²²⁶ Ra	0.3		0.2		4
Gross alpha					
	Water	Filter	Wipe		Soil and sediment
Minimum sample size	200 mL	250 mL	Total		0.001 kg
Minimum counting time	200 min.	100 min.	100 min.		100 min.
Method detection limit	1 pCi/L	0.0006 pCi/mL	0.5 pCi/wipe		160 pCi/kg-dry
Gross uranium in water					
Minimum sample size			1000 mL		
Minimum counting time			200 min.		
Method detection limit			1 pCi/L		
Random scintillation counting system					
²²⁶ Ra (radium) in water					
Minimum sample size			1000 mL		
Minimum counting time			200 min.		
Method detection limit			0.04 pCi/L		
Liquid scintillation counting system					
³ H (tritium)			²²² Rn (radon) in water		
	In water	In tissue			
Minimum sample size	10 mL	3 g		10 mL	
Minimum counting time	100 min.	120 min.		60 min.	
Method detection limit	350 pCi/L	1200 pCi/kg-wet		25 pCi/L	

TABLE 15.0 Lower limit of detection (LLD) values for selected radionuclides for WCNOE environmental sample analysis. ^a

Analysis	Water (pCi/l)	Airborne (pCi/m ³)	Fish (pCi/kg-wet)	Milk (pCi/l)	Food Products ^b (pCi/kg-wet)	Sediment (pCi/kg-dry)	Aquatic Vegetation (pCi/kg-wet)
Gross Beta	4 (2)	0.01 (0.003)	*	*	*	*	*
³ H	2000 ^c (1000)	*	* (300)	*	*	*	*
⁵⁴ Mn	15	*	130	*	* (40)	* (30)	* (40)
⁵⁹ Fe	30	*	260	*	*	*	*
⁵⁸ Co and ⁶⁰ Co	15 (5)	*	130	*	* (10)	* (30)	* (40)
⁶⁵ Zn	30	*	260	*	*	*	* (10)
⁹⁵ Zr and ⁹⁵ Nb	15	*	*	*	* (10)	*	* (40)
¹³¹ I	1 ^d (0.5)	0.07 (0.007)	*	1 (0.3)	60	*	*
¹³⁴ Cs	15	0.05	130	15	60	150 (60)	* (20)
¹³⁷ Cs	18	0.06	150	18	80 (10)	180 (60)	* (10)
¹⁴⁰ Ba and ¹⁴⁰ La	15	*	*	15	*	*	*
⁵¹ Cr	*	*	*	*	*	*	* (500)
¹²⁵ Sb	*	*	*	*	*	*	* (50)
²²⁶ Ra	*	*	**	**	* (200)	* (500)	* (200)
²²⁸ Th	*	*	*	*	* (20)	* (40)	* (20)
⁷ Be	*	* (0.001)	*	*	* (100)	* (300)	* (100)
⁴⁰ K	*	* (0.002)	500	* (100)	* (500)	* (500)	* (500)

^a This table is adapted from Table 5-3 of WCNOE's Offsite Dose Calculation Manual (ODCM). Values in parenthesis reflect typical LLDs achievable by *Teledyne* Isotopes. This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported. The LLD is defined as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95 percent probability with only 5 percent probability of falsely concluding that a blank

$$LLD = 2.10 \times \left[\frac{S_b}{E V Y \exp(-\lambda t)} \right]$$

observation represents a "real" signal. For a particular measurement system, which may include radio-chemical separation:

Where LLD is the *a priori* lower limit of detection (picoCuries per Unit mass or Volume), S_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts per minute), E is the counting efficiency (counts per disintegration), V is the sample size (units of mass or volume), 2.10 is a conversion factor with units picoCurie per disintegration per minute (4.66/2.22 dpm/pCi), Y is the fractional radiochemical yield (when applicable), λ is the radioactive decay constant for the particular radionuclide (s⁻¹), and λt is the elapsed time between sample collection (or end of the sample collection period), and time of counting (s).

It should be recognized that the LLD is defined as an *a priori* (before the fact) limit representing the capability of a measurement system and not used as an *a posteriori* (after the fact) limit for a particular measurement. Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidable small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors shall be identified and described.

^b Includes terrestrial vegetation.

^c LLD for drinking water samples. If no drinking water pathway exists, a value of 3000 pCi/l may be used.

^d LLD for drinking water samples. If no drinking water pathway exists, the LLD of gamma isotopic analysis may be used.

Note: If the above equation is used with an actual background count of a sample and a recently determined counting efficiency (using *a posteriori* values instead of assumed *a priori* values), the minimum detectable activity (MDA) may be calculated. Ideally, the MDA will be very close to the LLD. The LLD is a device to predict the detection capability of the counting system, while the MDA reflects the actual detection capability of a counting system. An MDA should be determined for each sample analyzed. The method detection limit (MDL) and MDA are equivalent.

TABLE 16.0 KDHE radiochemistry laboratory Performance Evaluation Sample Results SFY 2000. Data in pCi/l.

Date	Analysis	Control		Control limits		Mean	KDHE
		Known Value	Expected Precision	Min	Max		Standard Error of the Mean
Gross alpha in water							
10-Feb-00	Gross alpha	58.4	±14.6	33.3	83.5	49.6	±3.2
17-Apr-00		54.0	±13.5	30.8	77.2	44.0	±0.3
Gross beta in water							
10-Feb-00	Gross beta	16.8	±5.0	8.0	25.5	10.1	±1.4
17-Apr-00		289.0	±43.4	214.0	364.0	292.0	±16.9
Strontium in water							
01-Jan-00	⁸⁹ Sr	22.5	±5.0	13.8	31.2	21.3	±0.6
	⁹⁰ Sr	9.6	±5.0	0.9	18.3	10.7	±0.6
17-Apr-00	⁸⁹ Sr	50.7	±5.0	42.0	59.4	51.8	±1.2
	⁹⁰ Sr	32.8	±5.0	24.1	41.5	33.5	±2.1
Iodine in water							
20-Mar-00	¹³¹ I	19.9	±3.0	14.7	25.1	19.7	±0.2
Gamma in water							
17-Apr-00	⁶⁰ Co	16.9	±5.0	8.2	25.6	18.7	±0.6
	¹³⁴ Cs	76.7	±5.0	68.0	85.4	79.7	±0.6
	¹³⁷ Cs	123.0	±6.2	112.3	133.7	118.0	±3.6
05-Jun-00	⁶⁰ Co	65.6	±5.0	56.9	74.3	70.0	±1.0
	⁶⁵ Zn	54.6	±5.5	45.3	63.9	57.0	±1.0
	¹³⁴ Cs	13.8	±5.0	5.1	22.5	12.7	±0.6
	¹³⁷ Cs	238.0	±11.9	217.0	259.0	228.0	±4.5
	¹³³ Ba	25.5	±5.0	16.8	34.2	24.0	±1.0
Tritium in water							
01-Mar-00	³ H	23800.0	±2380.0	19800.0	27800.0	23500.0	±312.0

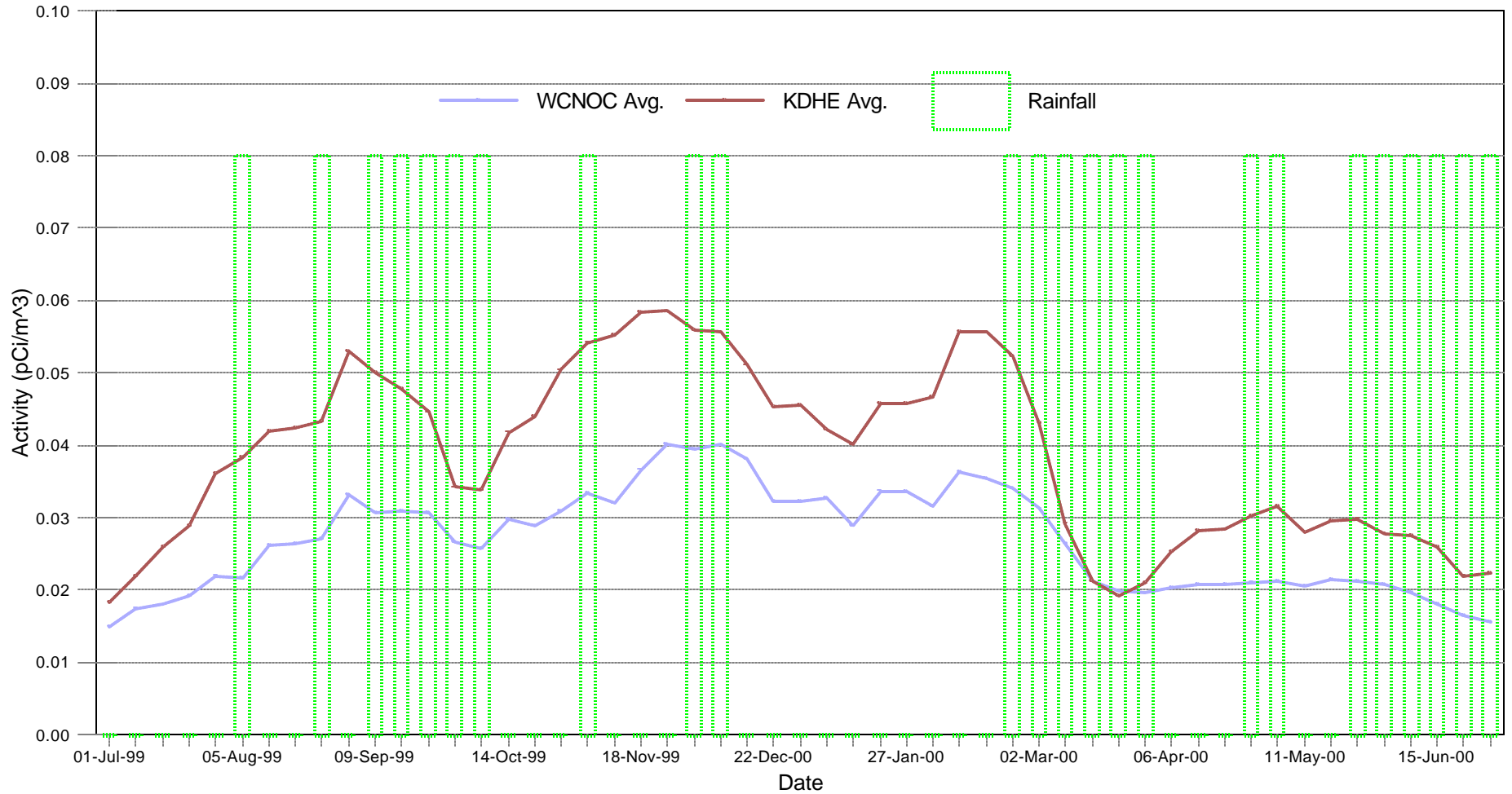
**WOLF CREEK GENERATING STATION
ENVIRONMENTAL RADIATION SURVEILLANCE REPORT
KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT
SFY 2000**

GRAPHS

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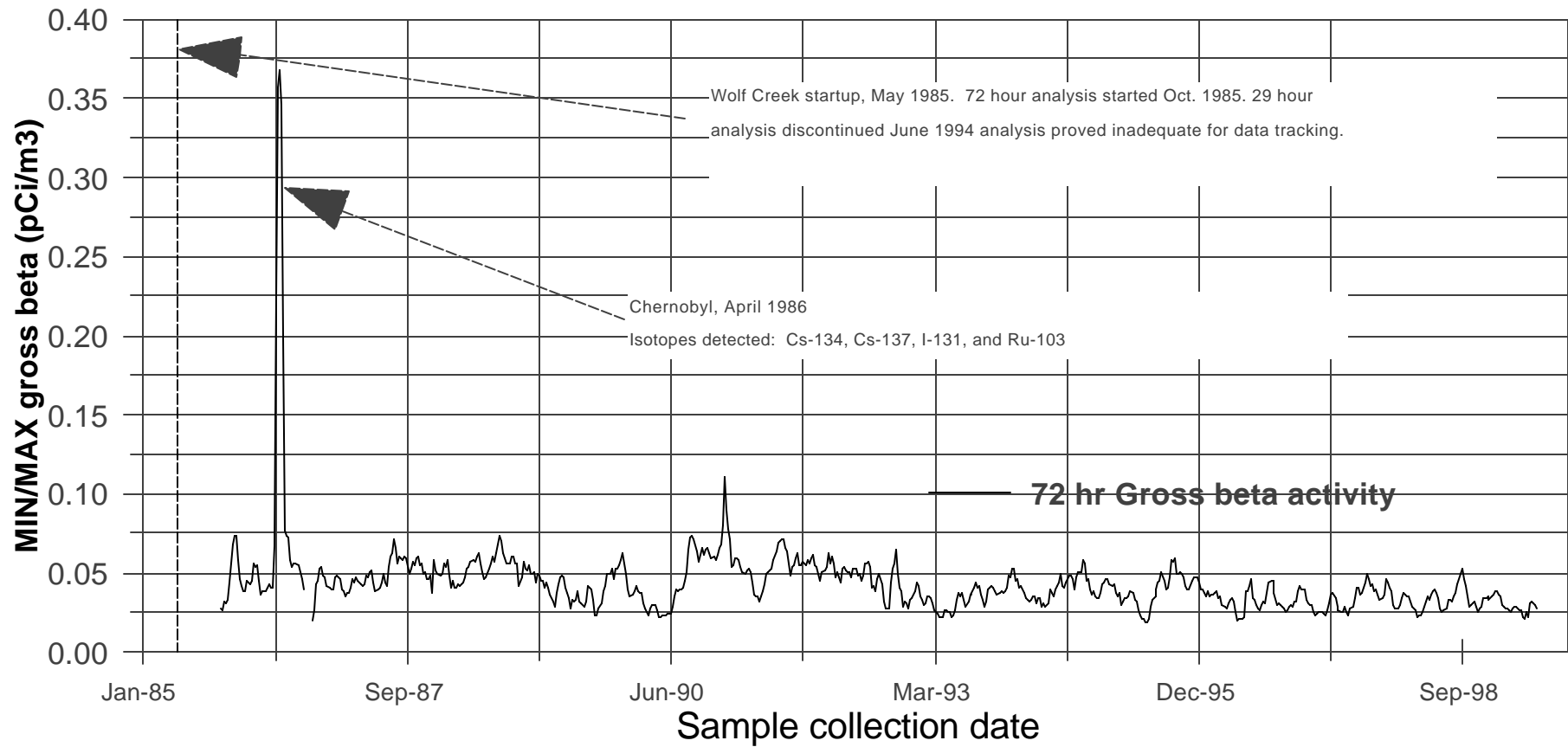
Weekly Air Sample Gross Beta Data

Four Week Rolling Smoothed Average



Graph 1.0 Comparison of KDHE/ WCNOC averaged data vs. rainfall

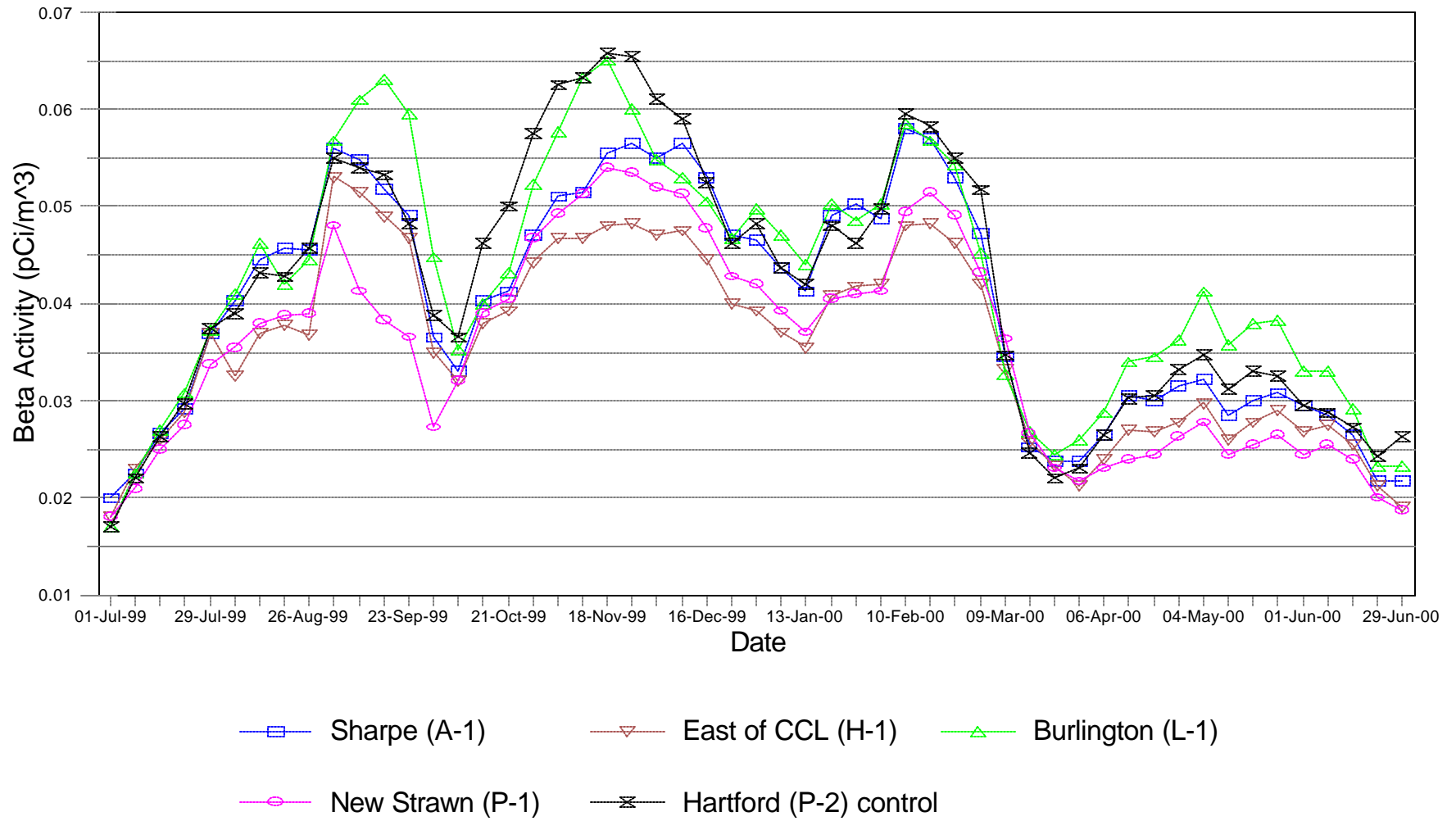
Historical Wolf Creek air Gross beta results



Graph 1.1 HISTORICAL KDHE WEEKLY AIR PARTICULATE GROSS BETA RESULTS

Weekly Gross Beta Results

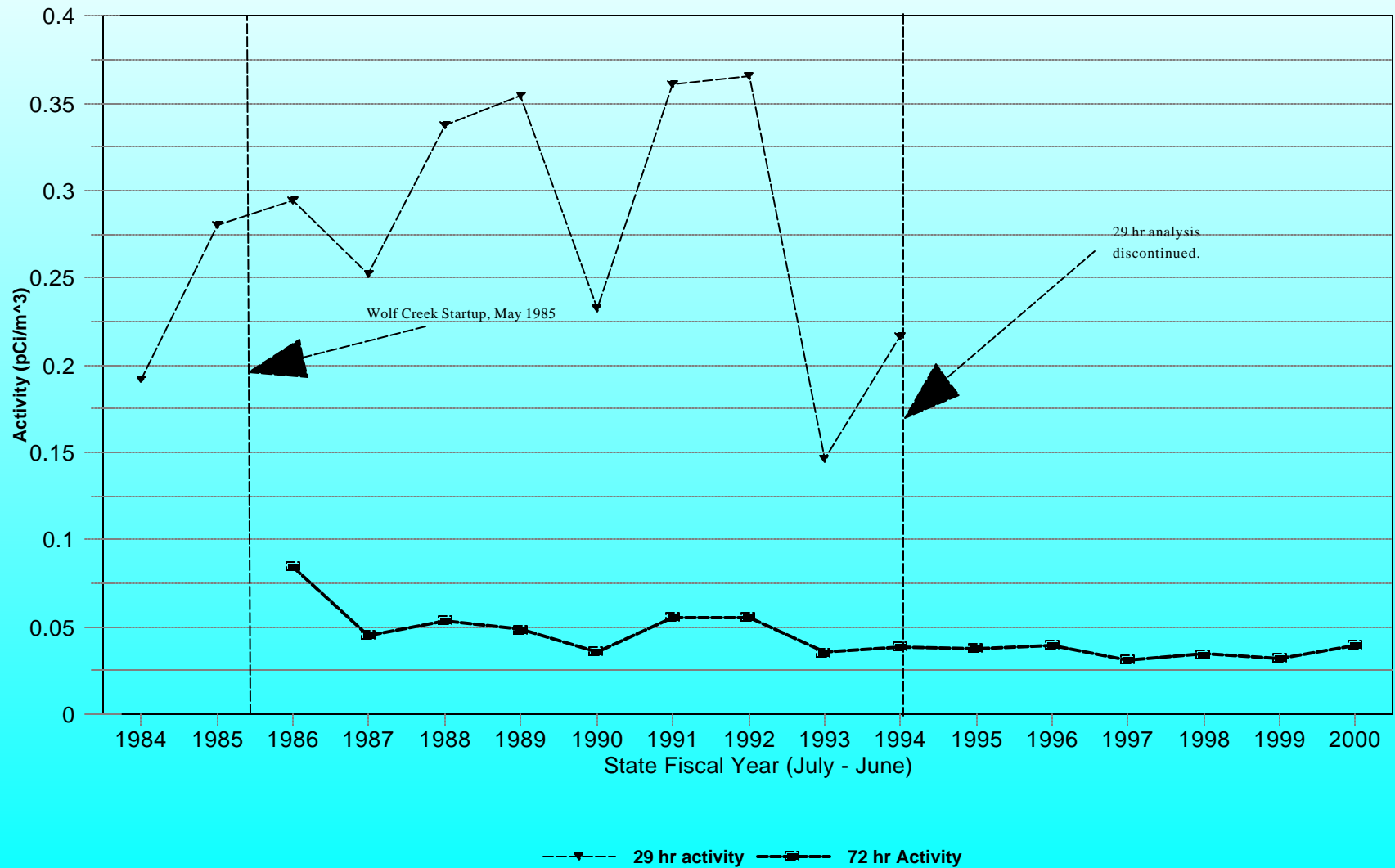
All KDHE Stations



Graph 1.2 WEEKLY AIR PARTICULATE GROSS BETA RESULTS
(Rolling 4 week smoothed average)

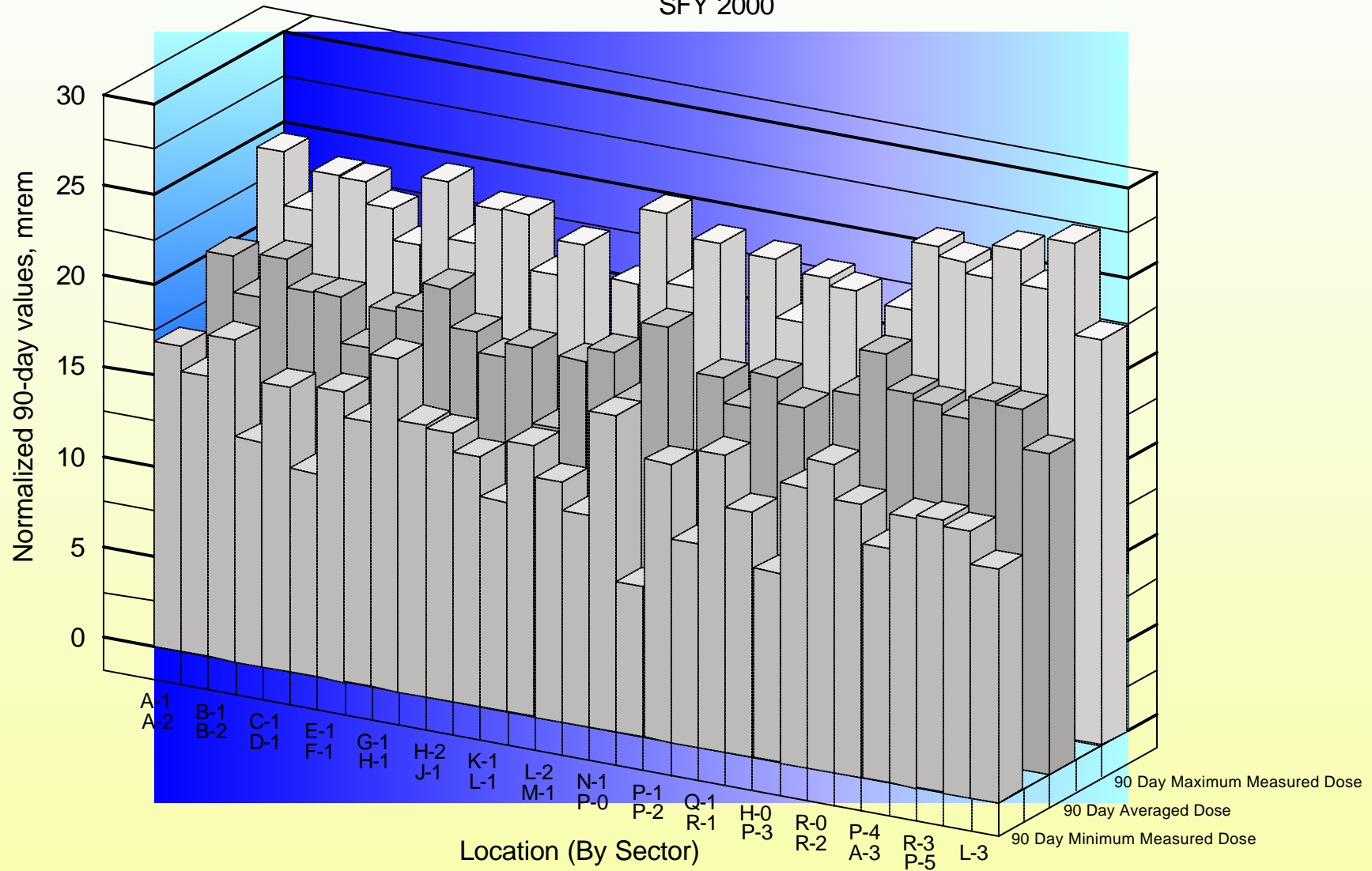
Annual Average Airborne Activity

Average of all Stations



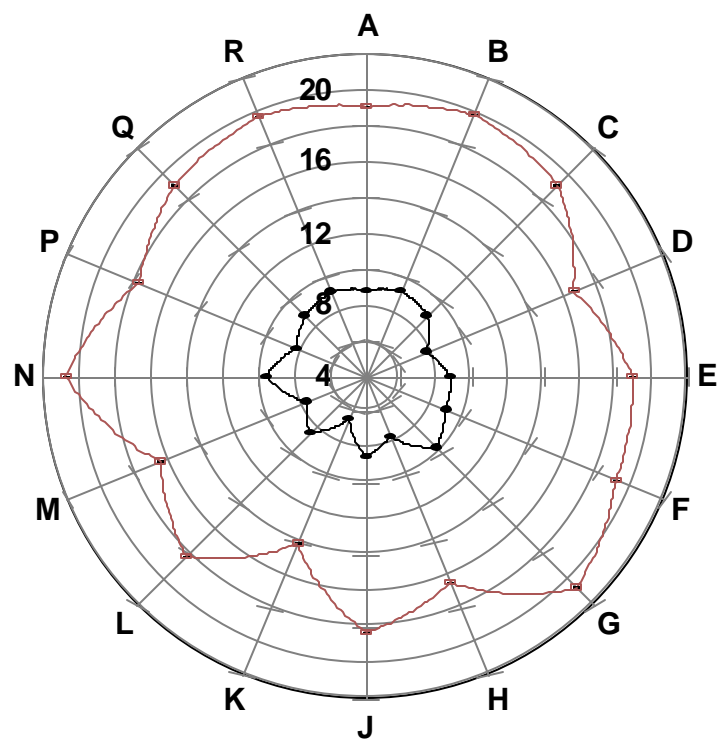
Graph 1.3 Annual airborne Average (For All Stations).

Direct Radiation SFY 2000



Graph 2.0 Quarterly Direct Radiation Monitoring (TLD) Results

Averaged Direct Radiation Data By Sector

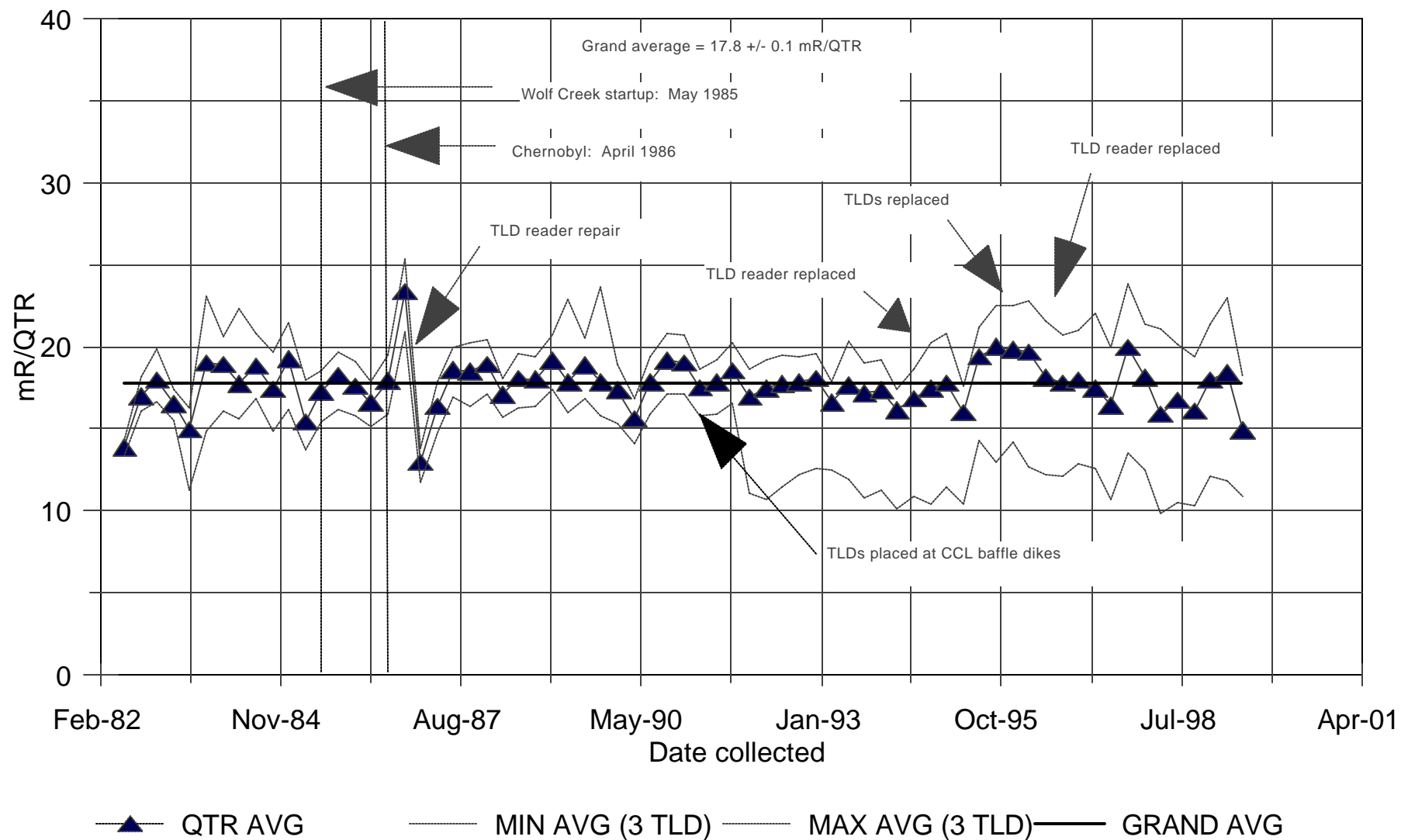


Averaged Dose Rate (urem/hr)

 Averaged Quarterly Dose (mrem)

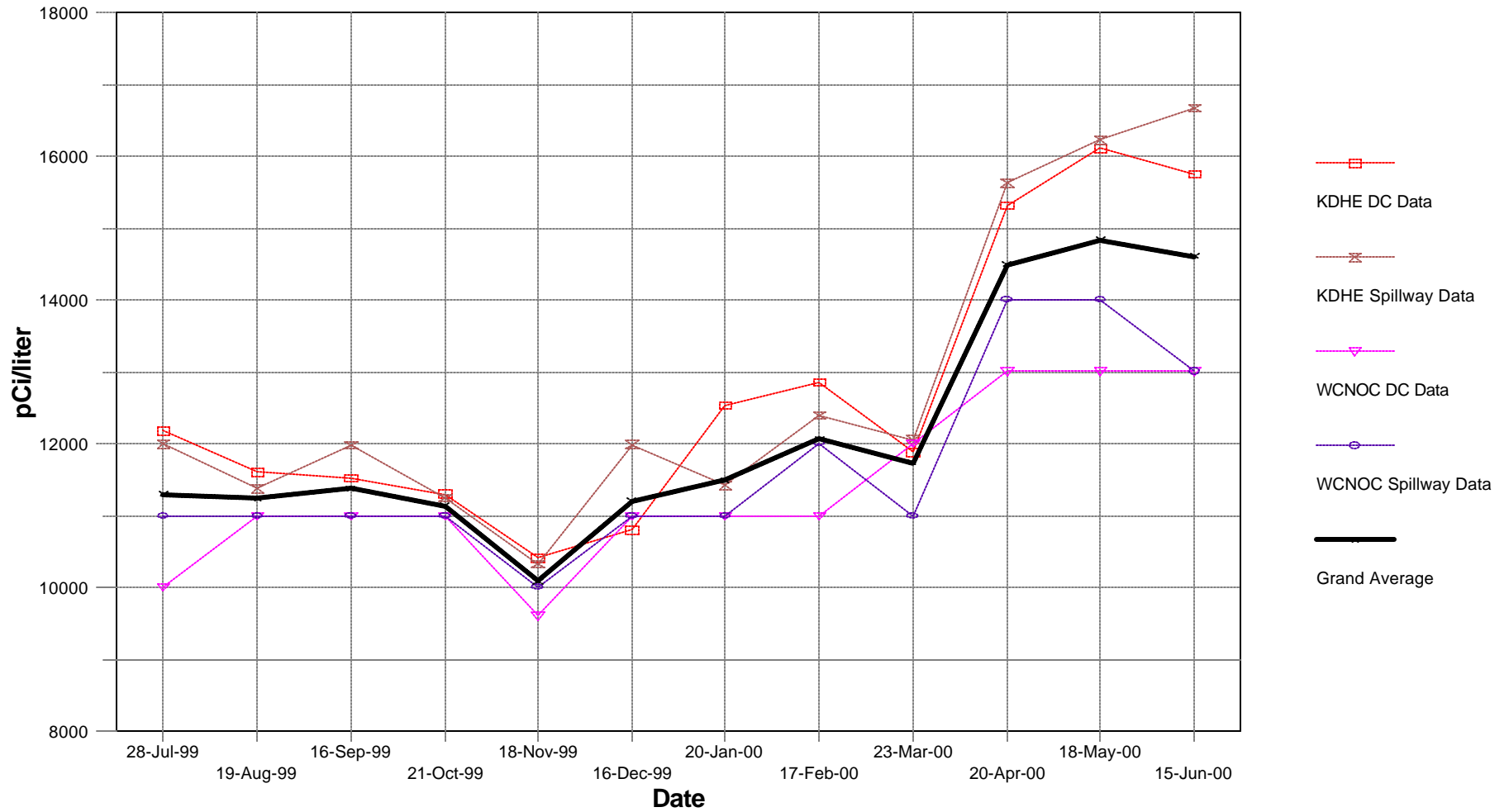
Graph 2.1 Averaged Radiation Data By Sector

Historical TLD results Wolf Creek



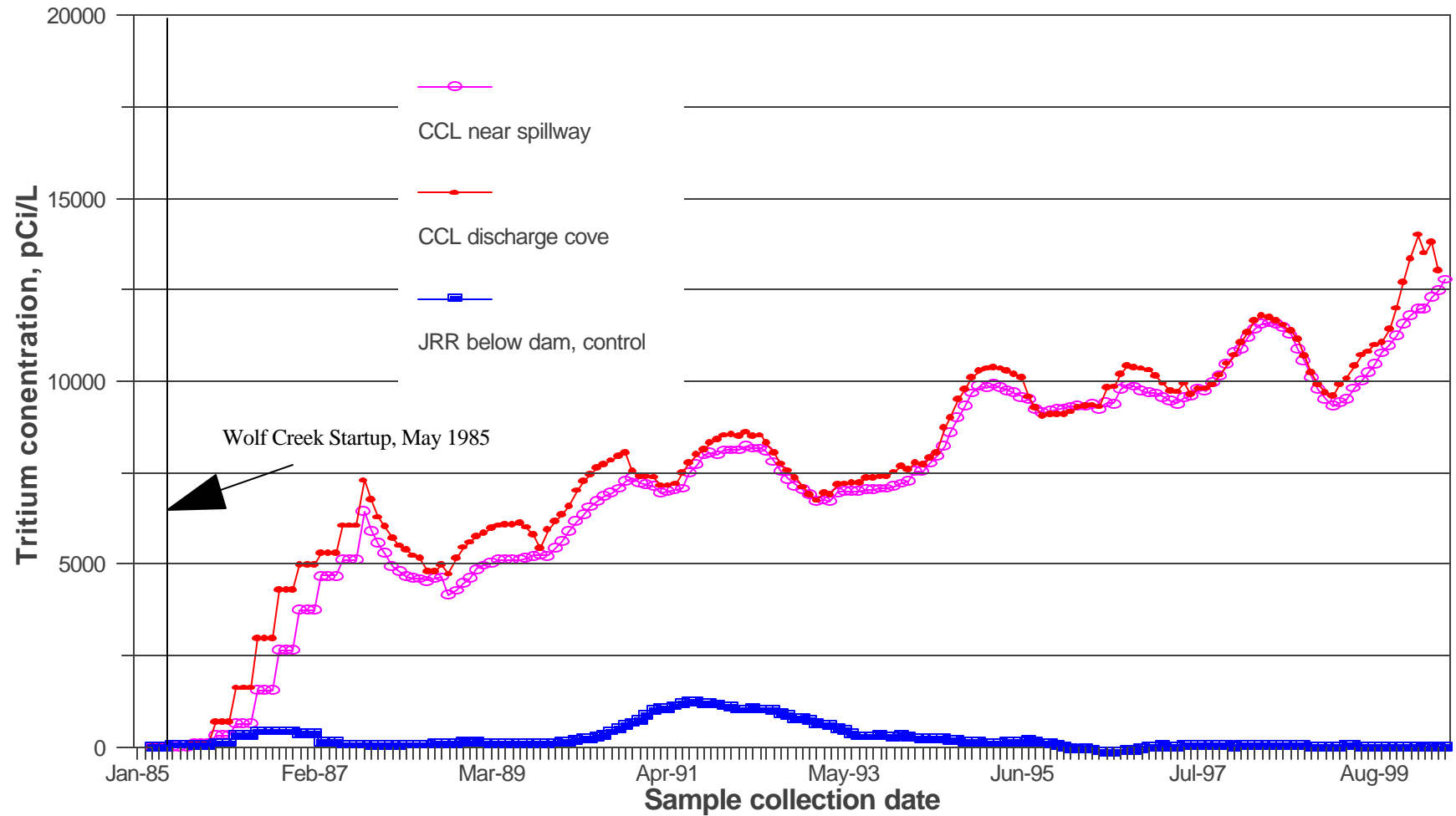
Graph 2.2 Historical TLD Data (Pre- operational to present)

Wolf Creek Monthly Surface Water Tritium (H3) Concentration



Graph 3.0 Comparison of CCL surface Water Tritium Levels

Historical Surface water Tritium (H3) (12 month rolling avg.)

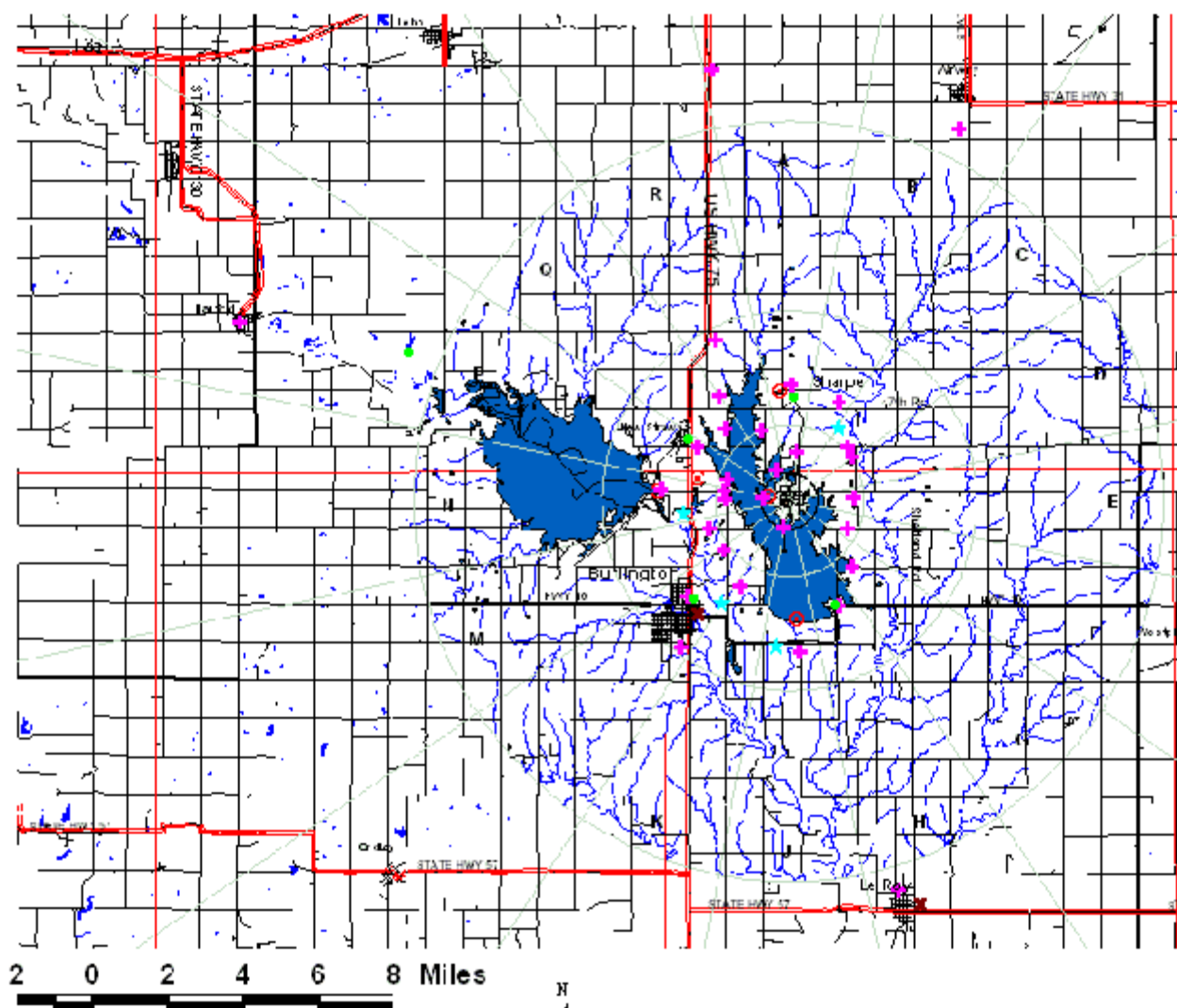


Graph 3.1 Historical CCL Tritium Levels (with Control tritium levels for comparison)

**WOLF CREEK GENERATING STATION
ENVIRONMENTAL RADIATION SURVEILLANCE REPORT
KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT
SFY 2000**

FIGURES

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- ✕ Drinking Water
- Air Sample Sites
- ✱ TLD Sites
- ⊙ Surface Water
- Linsey Dairy, LeboMilk Samples
- ★ Ground Water

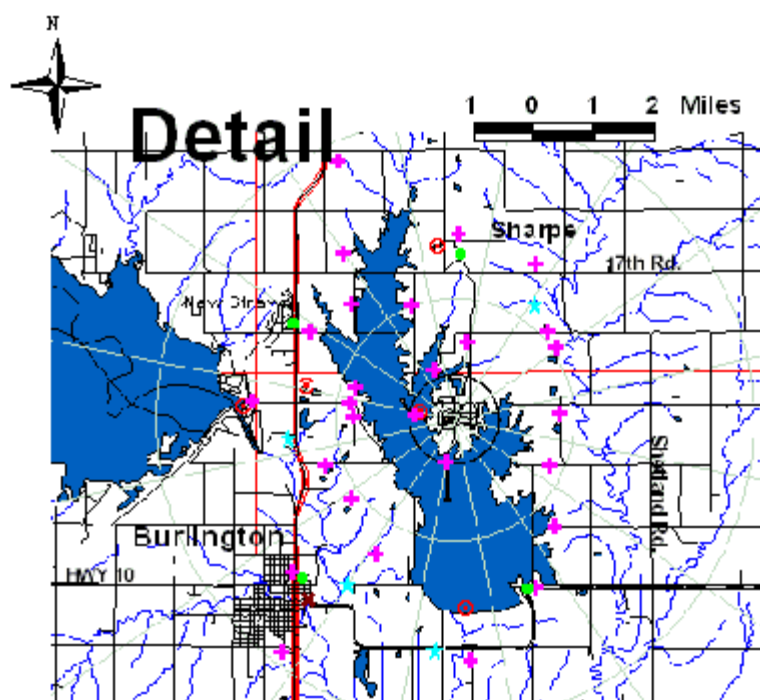


Figure 1

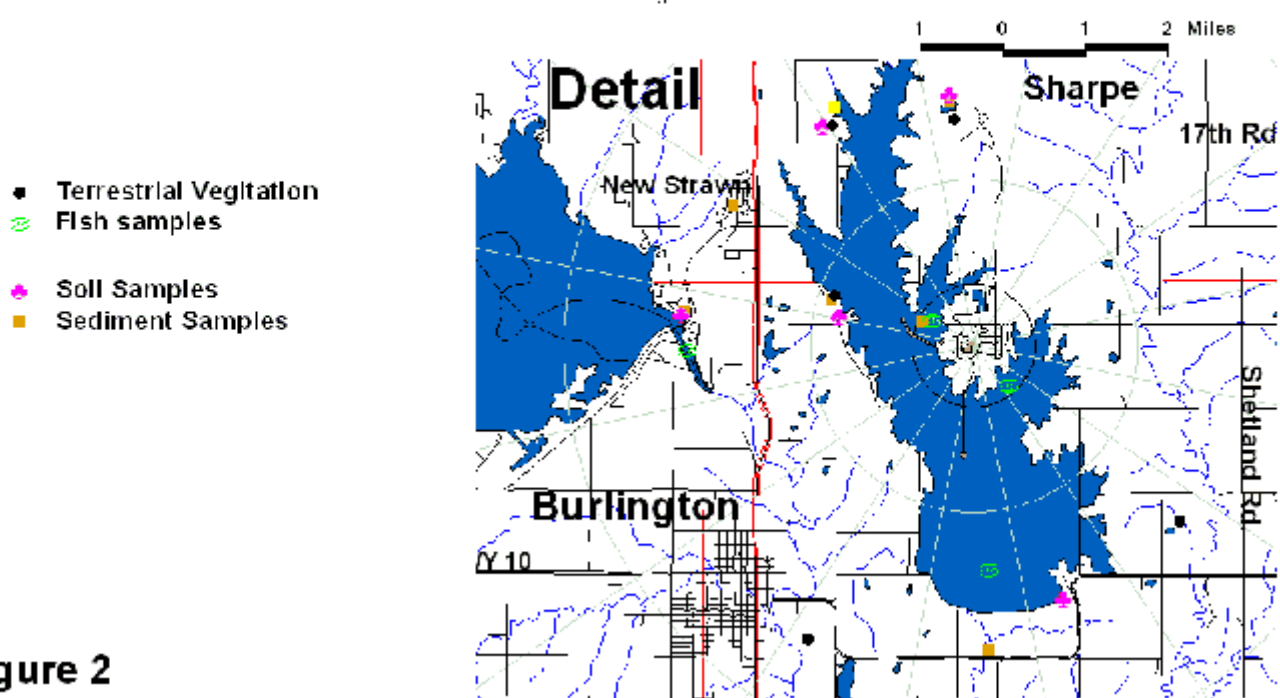
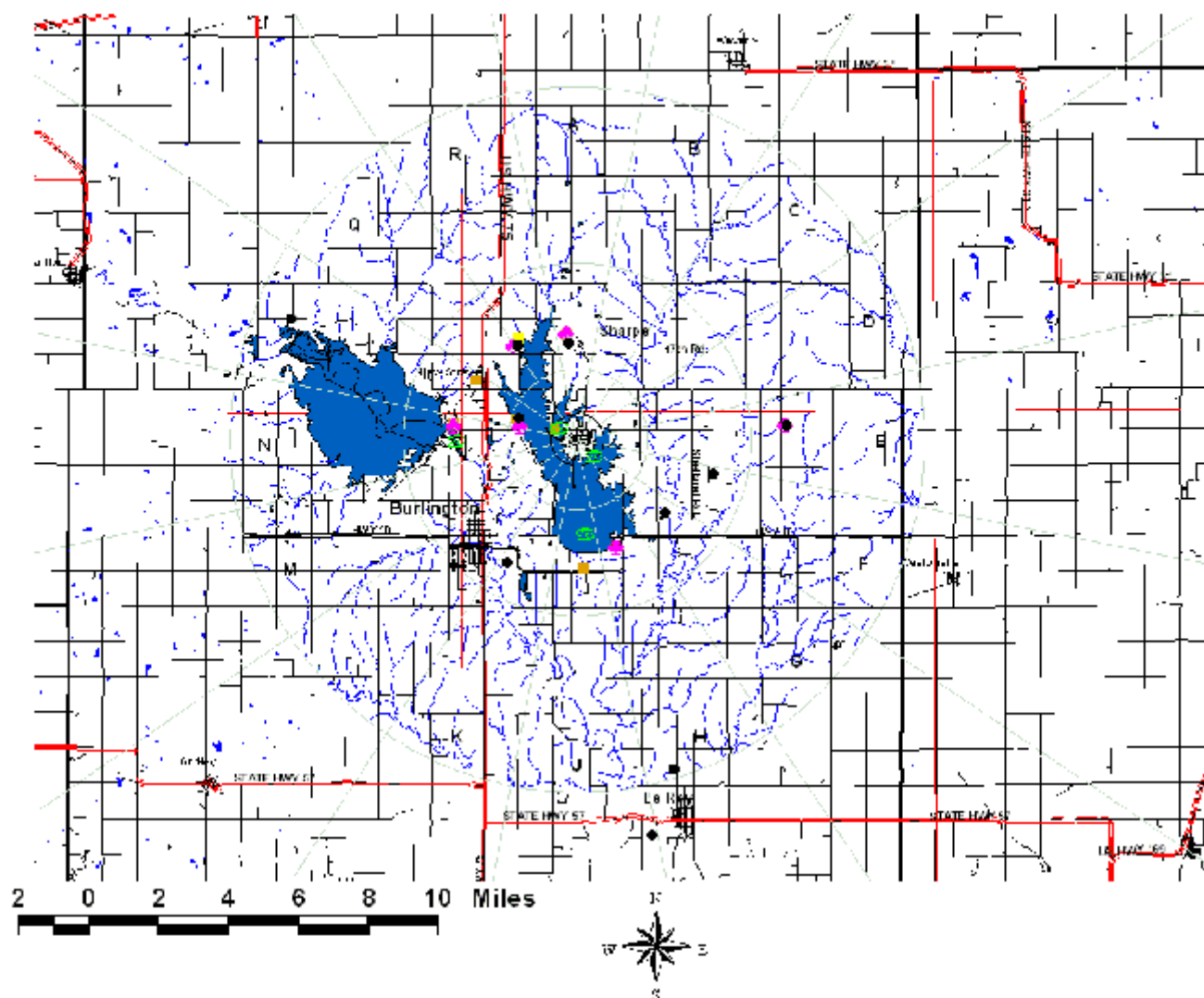


Figure 2